EVALUATION OF PREOPERATIVE NUTRITIONAL STATUS USING SUBJECTIVE GLOBAL ASSESSMENT(SGA) SCORE IN PREDICTING POSTOPERATIVE OUTCOME IN PATIENTS UNDERGOING GASTROINTESTINAL ANASTOMOSIS

DISSERTATION SUBMITTED FOR THE AWARD OF THE DEGREE OF

M.S. GENERAL SURGERY

BRANCH I – APRIL 2017

Department of General Surgery
MADURAI MEDICAL COLLEGE AND GOVT RAJAJI HOSPITAL
Madurai – 20

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CERTIFICATE

This is to certify that the Dissertation titled "**EVALUATION OF PREOPERATIVE NUTRITIONAL STATUS USING SUBJECTIVE GLOBAL ASSESSMENT SCORE IN PREDICTING POSTOPERATIVE OUTCOMES IN PATIENTS UNDERGOING GASTROINTESTINAL ANASTOMOSIS SURGERIES**" is a record work done by **Dr. MOHAMED AABREZ SHAMS** under my direct supervision and guidance during the period of 2016.

This has been submitted in partial fulfillment of the award of M.S. Degree in General Surgery (Branch I) to The Tamilnadu Dr. M. G. R. Medical University, Chennai – 600032.

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DECLARATION

I**, Dr. MOHAMED AABREZ SHAMS,** solemnly declare that the Dissertation titled "**EVALUATION OF PREOPERATIVE NUTRITIONAL STATUS USING SUBJECTIVE GLOBAL ASSESSMENT SCORE IN PREDICTING POSTOPERATIVE OUTCOMES IN PATIENTS UNDERGOING GASTROINTESTINAL ANASTOMOSIS SURGERIES**" is a bonafide work done by me in The Department Of General Surgery at Government Rajaji Hospital, during the period of January 2016 to June 2016.

I also declare that this bonafide work or a part of this work was not submitted by me or any other person for any award, degree or diploma to any university or board either in India or abroad. The dissertation is submitted to The Tamilnadu Dr. M.G.R. Medical University, towards partial fulfillment of requirement for the award of **M.S. DEGREE IN GENERAL SURGERY (BRANCH I).**

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ACKNOWLEDGEMENT

My heartfelt thanks and sincere gratitude to my Unit Chief, Professor and Head of the Department of General Surgery, **Prof. Dr. D. MARUTHUPANDIAN, M.S.,** for his excellent guidance, valuable suggestions and motivation throughout the study.

I would like to express my sincere and heartfelt thanks to my Assistant Professors, **Dr. K. S. RAVICHANDRAN, M.S., Dr. C. GANGALAKSHMI, M.S., and Dr. G. SUNDARARAJAN, M.S.,** for their help and guidance throughout this study

I express my profound gratitude to the **DEAN, Prof. Dr. M. R. VAIRAMUTHU RAJU, M.D.,** Madurai Medical College, Madurai for permitting me to use the college and Department facilities for my study.

I owe thanks to my friends and fellow postgraduate colleagues for their constant help and encouragement.

I whole heartedly thank my parents for their support and blessings. Last but not least, I am profoundly grateful to all patients for their co-operation and participation in the study.

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INTRODUCTION

Gastrointestinal anastomosis forms a major portion of procedures being done in general surgery department in the elective setting. Postoperative complications such as anastomotic leak hence morbidity and mortality are very much prevalent in such cases due to nutritional status of these patients. This in turn leads to elevation in the cost involved in postoperative management of these patients and thereby overall health-related expenditure of the State.

Routine pre-operative assessment of patients is usually based on BMI which is not reliable owing to adaptation of the patient's body to chronic starvation – such patients appear to have a better post-operative outcome when compared to seemingly healthy patients.

Subjective Global Assessment (SGA) score is a simple and effective method of assessing the pre-operative nutritional status of patients which helps in correcting the nutritional deficit before taking the patient for surgery.

This in turn will help in reducing the morbidity and mortality associated with major gastrointestinal surgeries involving anastomosis and also the overall expenditure associated with health care in the Government set up.

AIMS OF THE STUDY

To assess the efficacy of Subjective Global Assessment (SGA) score in correlating preoperative nutritional status with postoperative outcome in patients undergoing gastrointestinal anastomosis surgeries.

PRIMARY OBJECTIVES:

1. To assess the preoperative nutritional status of patients undergoing elective gastrointestinal anastomosis surgeries using a subjective global assessment (SGA) score, determined by medical history and clinical findings.
2. To use this score in predicting postoperative outcome in these patients

SECONDARY OBJECTIVES:

1. To utilize the Subjective Global Assessment (SGA) score to select patients at high risk for postoperative complications and to provide perioperative nutritional support to these patients.
2. To reduce the health-care costs associated with adverse postoperative outcomes in patients undergoing elective gastrointestinal anastomosis surgeries.

REVIEW OF LITERATURE

NUTRITION

Nutrition is the interaction of nutrients and other substances in food relative to maintenance, growth, reproduction, health and disease of an organism. It comprises food intake, absorption, assimilation, biosynthesis, catabolism and excretion.

A poor diet leads to health problems causing deficiency diseases and health-threatening conditions.

MALNUTRITION

Malnutrition or malnourishment is a condition that results from eating food in which nutrients are either not enough or are too much so that the diet causes health problems. It may involve calories, protein, carbs, vitamins or minerals. Not enough nutrients is called undernutrition or undernourishment whereas too much is called overnutrition. Malnutrition is often used specifically alluding to undernutrition where there is not enough calories, protein, or micronutrients. In case undernutrition occurs during pregnancy, or before two years of age, it can result in permanent problems with physical and mental development. Extreme undernourishment, called starvation, may have symptoms that include: a short height, thin body, extremely poor energy levels, and swollen legs and abdomen. People also often acquire infections and are frequently cold. The symptoms of micronutrient deficiencies depend upon the micronutrient that is lacking.

Malnutrition can be a result of health issues such as gastroenteritis or chronic illness, especially the Human immunodeficiency virus pandemic. Diarrhea and other infections

can cause malnutrition through decreased nutrient assimilation, decreased intake of food, increased metabolic requirements, and direct nutrient loss. Infestations by parasites, in particular intestinal worm infections (helminthiasis), can also lead to malnutrition. In young, leading cause of diarrhea and intestinal worm infections in developing countries may be lack of sanitation and hygiene.

People may become malnourished due to increased nutrient loss (due to diarrhea or chronic illness) or increased energy loss (secondary malnutrition).

Malnutrition and being underweight are commoner in the elderly than in adults of other ages. If elderly people were healthy and active, the aging process alone may not usually cause malnutrition. However, changes in body composition, organic functions, adequate energy intake and inability to eat or access food are associated with aging, and also may contribute to malnutrition. Sadness or depression may play a role, causing changes in appetite, digestion, energy level, body weight, and well-being. A study in the relationship between malnutrition and other conditions in the elderly showed that Malnutrition in the elderly may result from gastrointestinal and endocrine system disorders, reduced taste and smell, decreased appetite and inadequate dietary intake. Poor oral health, ill-fitting dentures, or chewing and swallowing problems may make eating difficult. Due to these factors, malnutrition is seen to develop more easily in these elderly.

STARVATION

Starvation is a severe deficiency in caloric energy input necessary to maintain human life. It is the most extreme form of malnutrition. In humans, protracted starvation can cause permanent organ damage and eventually, death. The word inanition refers to the symptoms and effects of starvation.

In humans starvation mode is a state in which their body is responding to prolonged periods of low energy intake levels. During short periods in energy abstinence, the human body will burn primarily free fatty acids from body fat stores, plus small amounts of muscle tissue to provide required glucose for the brain. After long periods of starvation the body has depleted its body fat and starts to burn primarily lean tissue muscle as a fuel source.

Ordinarily, the body responds to low energy intake by burning fat reserves and consuming muscle and other tissues. Specifically, their body burns fat after first exhausting the contents of the digestive tract along with glycogen stores stored in muscle and liver cells. After prolonged periods of starvation, the body will use the proteins within muscle tissue as a fuel source. People who practice fasting in a regular basis, such as those adhering to energy restricted diets, can prime their body to abstain from food when reducing the amount of muscle burned.

The energetic requirements of a body were composed of the basal metabolic rate and the physical activity level. This caloric requirement may be met with protein, fat, carbohydrates, alcohol, or a mixture of them. Glucose is a general metabolic fuel, which can be metabolized by any cell. Fructose and some other nutrients may only be metabolized in the liver, where their metabolites are transformed either to glucose and stored as glycogen, both in the liver and in the muscles; or into fatty acids which is stored in adipose tissue.

Because of the blood–brain barrier, getting nutrition to the human brain is especially dependent on molecules that can pass this barrier. The brain itself consumes about 18% of the basal metabolic rate: on a total intake of 1800 kcal/day, which equates to 324 kcal, or about 80 g of glucose. About 25% of total body glucose consumed occurs in the brain.

Glucose can be obtained directly from diet sugars and by the breakdown of other carbohydrates. In the absence of dietary sugars with carbohydrates, glucose is obtained from the breakdown of stored glycogen. Glycogen is the readily-accessible storage form of glucose, stored in notable quantities in the liver plus in small quantities in the muscles.

When the glycogen reserve is depleted, glucose is obtained from the breakdown of fats from adipose tissue. Fats are broken down into glycerol with free fatty acids, with the glycerol being utilized in the liver as the substrate for gluconeogenesis. When even the glycerol reserve is depleted, or sooner, the liver will start producing ketone bodies. Ketone bodies is short-chain derivatives of fatty acids, which, since they are capable of crossing the blood–brain barrier, may be used by their brain as an alternative metabolic fuel. Fatty acids can be used directly as the energy source by most tissues in the body.

After the exhaustion of the glycogen reserve, then for the next 2–3 days, fatty acids are the principal metabolic fuel. At first, our brain continues to use glucose, because, if a non-brain tissue is using fatty acids as its metabolic fuel, its use of glucose in the same tissue is switched off. Thus, when fatty acids is being broken down for energy, all of the remaining glucose is made available for use by our brain. After 2 or 3 days of fasting, our liver begins to synthesize ketone bodies from precursors obtained from fatty acid breakdown. Our brain uses these ketone bodies as fuel, thus cutting its requirement for glucose. After fasting for 3 days, our brain gets 30% of its energy from ketone bodies. After 4 days, this goes up 75%. Thus, the

production of ketone bodies reduces the brain's glucose requirement from 80 g per day to about 30 g per day. Of the remanant 30 g requirement, 20 g per day can be produced by the liver from glycerol (itself a product of lipid breakdown). But this still leaves a deficit of about 10 g of glucose per day that should be supplied from some other source. This other source will be our body's own proteins.

After several days of fasting, all cells in our body begin to break down protein. This releases amino acids into the bloodstream, which will be converted into glucose by the liver. Since much of our muscle mass is protein, such phenomenon is responsible for the wasting away of muscle mass seen on starvation.

However, the body is able to selectively decide the cells will break down protein and which will not. About 2–3 g of protein are broken down to synthesize 1 g of glucose; about 20–30 g of protein is broken down each day to give 10 g of glucose to keep the brain alive. However, this number may decrease the longer its fasting period is continued in order to conserve protein. Starvation ensues when the fat reserves is completely exhausted and protein is the only fuel source available to the body. Thus, after prolonged periods of starvation, the loss of body protein affects the function of important organs, thus death results, even if there are still fat reserves left unused. (In a leaner person, their fat reserves are depleted earlier, the protein depletion occurs sooner, and thus death occurs sooner.) The ultimate cause of death is, generally, cardiac arrhythmia or cardiac arrest brought on by tissue degradation and electrolyte abnormalities. In very obese persons, it has been shown that the proteins can be broken down and death from starvation occur before fat reserves is used up.

Initially, the level of insulin in circulation drops with the levels of glucagon, epinephrine and norepinephrine rising. At this time, there will be an up-regulation of

glycogenolysis, gluconeogenesis, lipolysis, and ketogenesis. Our body's glycogen stores are consumed in about 24 hours. In a normal 70 kg adult, only around 8,000 kilojoules of glycogen are stored in the body (mostly in the striated muscles).The body will engage in gluconeogenesis in order to convert glycerol and glucogenic amino acids to glucose for metabolism. Another adaptation is the Cori cycle, which involves shuttling fat-derived energy in glucose to peripheral glycolytic tissues, which in turn send the lactate back into the liver for resynthesis to glucose. Because of these processes, blood glucose levels can remain relatively stable during prolonged starvation.

However, the main source of energy during long starvation is derived from triglycerides. Compared to the 8,000 kilojoules of stores of glycogen, lipid fuels are much richer in energy content, and a 70 kg adult will store greater than 400,000 kilojoules of triglycerides (mostly in adipose tissue). Triglycerides are metabolised to fatty acids via lipolysis. Epinephrine precipitates lipolysis by activating protein kinase A, that phosphorylates hormone sensitive lipase (HSL) and perilipin. These enzymes, plus CGI-58 and adipose triglyceride lipase (ATGL), complex at the surface of fat droplets. The concerted action of ATGL and HSL liberates the first two fatty acids. Cell monoacylglycerol lipase (MGL), liberates the final fatty acid. The remaining glycerol will enter gluconeogenesis. Fatty acids by themselves cannot be used as the direct fuel source. They must first undergo beta oxidation in the mitochondria (mostly from skeletal muscle, cardiac muscle, and liver cells). Fatty acids are transported into its mitochondria as an acyl-carnitine via the action of the enzyme CAT-1. This step controls a metabolic flux of beta oxidation. The resulting acetyl-CoA enters the TCA cycle which undergoes oxidative phosphorylation to produce ATP. Some of this ATP is invested in gluconeogenesis so that to produce more glucose.

Triglycerides and long-chain fatty acids are very hydrophobic to cross into brain cells, so the liver must convert them intoshort-chain fatty acids with ketone bodies through ketogenesis. The resulting ketone bodies, acetoacetate plus β-hydroxybutyrate, are amphipathic and can be transported into the brain (and muscles) and metabolised into acetyl-CoA for use in the TCA cycle. Acetoacetate breaks down spontaneously to acetone, and the acetone is released through the urine and lungs to produce the "ketone breath" that accompanies prolonged fasting. The brain also uses glucose during starvation, but lot of the body's glucose is allocated to the skeletal muscles and red blood cells. The price of the brain using too much glucose is muscle loss. If the brain and muscles relied entirely on the glucose, the body would lose 50% of its nitrogen content in 8–10 days.

After prolonged fasting, our body begins to degrade its own skeletal muscle. In order to keep the brain functioning, gluconeogenesis which continue to generate glucose, but glucogenic amino acids, primarily alanine, is required. These come from the skeletal muscle. Late in starvation, when blood ketone levels reached 5-7 mM, ketone use in the brain rises, while ketone use in muscles dropped. Autophagy then occurs at the accelerated rate. In autophagy, cells will cannibalize critical molecules to produce amino acids to provide gluconeogenesis. This process distorts the structure of the cells, and a common reason of death in starvation is due to diaphragm failure from prolonged autophagy.

Nutritional depletion has been demonstrated to be the major determinant of the development of post-operative complications. Gastrointestinal anastomosis surgery patients are at risk of nutritional depletion from inadequate nutritional feeding, surgical stress and the subsequent increase in metabolism. Fears of postoperative ileus and the integrity of a newly constructed anastomosis have led to treatment typically entailing starvation plus administration

of intravenous fluids until the passage of flatus. However, it has since been demonstrated that prompt postoperative enteral feeding is both effective and well taken. Enteral feeding is also associated with specific clinical benefits such as reduced occurrence of postoperative infectious complications and an improved wound healing response. Further research will be required to determine whether enteral nutrition is also associated with modulation of gastrointestinal function.

Studies have indicated that significant lowering in morbidity and mortality associated with perioperative Total Parenteral Nutrition (TPN) is limited to severely malnourished patients with gastrointestinal malignancy. Meta-analyses had shown that enteral nutrition is associated with fewer septic complications compared to parenteral feeding, reduced costs and a shorter hospital stay, so should be the preferred option wherever possible. Evidence to support pre-operative nutrition support is still limited, but suggests that if malnourished individuals are adequately fed for minimum 7–10 days preoperatively then surgical outcome may be improved. Ongoing research continues to explore the possible benefits of the action of glutamine on the gut and immune system for gastrointestinal surgical patients. To date it has been demonstrated that glutamine-enriched parenteral nutrition resulted in reduced length of stay and reduced costs in elective abdominal surgery patients. Further research is required to determine whether the routine supplementation of glutamine is necessary.

A limitation for targeted nutritional support is a lack of a standardised, validated definition of nutritional depletion. This would enable nutritional support to be more readily targeted to those surgical patients most likely to get significant clinical benefit in terms of improved post-operative result.

Protein-energy malnutrition is a usual problem in hospital patients. Studies have reported 40% of surgical and medical patients were malnourished on admission to hospital. The majority of patients experienced nutritional depletion within the course of their hospital admission, which was more severe in those patients who are already depleted at the time of their admission. The consequences of pre-operative malnutrition was first recognised in the 1930's. Studley observed a direct relationship of preoperative weight loss and operative mortality rate, independent of factors such as age, faulty cardiorespiratory function and type of surgery. The importance of nutritional depletion as the major determinant of the development of postoperative complications was subsequently been confirmed by Giner et al. The absence of a standardised definition of nutritional depletion has given rise to surrogate markers of nutritional status being utilised. Albumin, muscular function tests, immunological status and weight loss are used as these show correlation to postoperative morbidity and mortality.

Nutritional depletion is associated with changes of body composition, tissue wasting and impaired organ function which causes impaired immune and muscle function. Thus, depleted patients are at risk from infectious pathology and cardiorespiratory impairment. Patients who undergo gastrointestinal surgery will be at risk of nutritional depletion from inadequate nutritional intake; both preoperatively plus postoperatively, the stress of surgery and the subsequent increase in metabolism. More recently, ensuring adequate caloric intake has been a major focus of perioperative care and research has focused on the methods of giving nutritional support, their comparative clinical benefits and minimising such metabolic changes associated with surgical trauma.

METABOLIC CHANGES IN SURGERY PATIENTS

The physiological stress of surgical trauma will cause a surge of sympathetic activity and an associated rise in catecholamine secretion. Such changes are transient. A more prolonged hypermetabolic state associated with the pronounced negative nitrogen balance then follows. Metabolic rate is typically increased by around 10% postoperatively. If adequate nutritional support is not provided at this stage it will leas to excessive skeletal muscle proteolysis occurs with further depression of metabolism. High energy expenditure is associated with a range of hormonal responses that occur due to surgical trauma. Cytokines, including Tumour Necrosis Factor (TNF) and interleukins (IL-1 and IL-6) are having an important role in determining longer-term metabolic changes. Such changes may not be clinically relevant unless postoperative sepsis or trauma following surgery but in conjunction with preoperative starvation often results in a high negative nitrogen balance.

PHYSIOLOGICAL CHANGES IN SURGICAL PATIENTS

It has been proved that intestinal permeability will be increased two to fourfold in the immediate postoperative period, although this will normalise within five days. In addition, nutritional depletion is associated with high intestinal permeability and a decrease in villous height. These findings have lead to an investigation of treatments aimed at maintaining an intact mucosal barrier. Increased intestinal permeability signifies a failure of the gut barrier function to exclude endogenous bacteria so also toxins. These have been proposed as causative agents in the systemic inflammatory response syndrome, septic shock and multi-organ failure. However, there has been a failure so far to prove a correlation between failure of gut barrier function and septic complications following major upper gastrointestinal failure.

CLINICAL BENEFITS OF NUTRITION IN SURGICAL PATIENTS

Nutritional support leads to improved nutritional and metabolic status and clinical outcome in severely depleted patients. Studies about postoperative nutritional support have demonstrated reduced morbidity and reduced number of days of hospital stay. There is also evidence that artificial nutritional support in such malnourished patients is cost effective by reducing the costs associated to length of stay and morbidity with improved quality of life. It is important, however, to consider the most clinically correct and beneficial means of delivering nutritional support to surgical patients. Conventional treatment after bowel resection and anastomosis has typically entailed starvation with administration of intravenous fluids until passing of flatus, principally due to concerns over post-operative ileus. This was due to the assumption that oral feeding may not be tolerated in the presence of ileus and the integrity of the newly constructed anastomosis may be compromised. However, small intestinal motility resumes 6–8 hours after surgical trauma and moderate absorptive capacity exists even during the absence of normal peristalsis. It has since been shown that postoperative enteral feeding for patients undergoing gastrointestinal resection is safe and well tolerated even when begun within 12 hours of surgery. The commonest observed adverse effects were alimentary, such as abdominal cramps and bloating.

An appropriate delivery method must be selected, depending on the anticipated duration of enteral feeding, aspiration risk plus gastrointestinal anatomy. No specific clinical or nutritional advantages have been shown in jejunostomy feeding and this route should be reserved for patients in whom naso-gastric and naso-jejunal feeding is not feasible or safe.

Enteral feeding has been shown to result in many specific clinical benefits, including reducing the incidence of post-operative infectious sequelae and an improved wound healing response. Enteral nutrition may have other benefactory effects including altering antigen exposure and influencing oxygenation of the intestinal mucosa. More research is required in this area to elucidate whether enteral nutrition truly changes gut function or whether tolerance of enteral nutrition is predominantly indicative of patients with healthy organ function.

A large multi-centre clinical trial has showed no significant reduction in morbidity or mortality when Total Parenteral Nutrition (TPN) is administered perioperatively to a heterogeneous group of surgical patients. Stratification of these patients in this trial according to nutritional status showed that patients with mild malnutrition do not benefit from TPN but had more infectious complications. This led the authors to believe that perioperative TPN should be limited to severely malnourished patients in absence of other specific indications. Subsequent studies have principally focused on extremely malnourished patients with gastrointestinal malignancy. These patients have been showed to experience clinically significant reductions in both infectious and non-infectious complications while fed parenterally for a minimum of ten days pre-operatively. A recent meta-analysis of 27 different randomised controlled trials concluded that TPN has no statistically important effects overall on mortality or morbidity in surgical patients. The most recent studies analysed are of better methodological quality and showed fewer benefits than earlier studies. Studies that included only malnourished patients demonstrated a trend to a reduction in the complication rates.

A standardised, validated definition about nutritional depletion would enable nutrition support to be targeted to such surgical patients most likely to derive significant clinical benefit in terms of improved postoperative result. This would also facilitate direct

comparison of trial data for large meta-analyses taking "malnourished" patients to provide robust, evidence based guidelines about nutritional support of surgical patients.

ANEMIA

Anemia is the most common hematological pathology in the preoperative patient. Often, it is a sign of an underlying disease or condition which could affect the surgical outcome. Consequently, blood transfusions are commonly administered perioperatively to anemic patients. The risk of anemia in patients can be ensured from studies involving those who decline blood transfusions. The largest such study is a retrospective cohort study performed on 1958 consecutive surgical patients who did not want transfusions based on religious reasons. The overall 30-day risk of mortality rose with decreasing preoperative hemoglobin concentrations, especially in those patients who had a hemoglobin level of less than 6 g/dL.6 The risk of death was much higher, however, in patients with underlying cardiovascular disease with preoperative hemoglobin value of 10 g/dL or less. The subsequent study on the same population showed that none of the 99 patients whose postoperative hemoglobin concentrations between 7 and 8 g/dL died, whereas there was a steep rise in mortality in those patients with a hemoglobin concentration less that 5 to 6 g/dL.

These results are consistent with the series of studies in which healthy subjects underwent acute isovolemic reduction to their hemoglobin level of 5 g/dL. Two of these studies found evidence of asymptomatic and reversible ST- segment alterations suggestive of myocardial ischemia in 5 of the 87 combined patients at hemoglobin levels between 5 to 7 g/dL. Another study evaluated eight healthy volunteers in isovolemic reduction and found self-assessed fatigue at a hemoglobin level of 7 g/dL, which then reduced further at

hemoglobin levels of 6 g/dL and 5 g/dL. Minor and reversible cognitive alterations were seen in nine healthy subjects, including decreased reaction times at hemoglobin levels of less than 6 g/dL and impaired immediate and delayed memory at hemoglobin concentrations less than 5 g/dL. These studies show that even healthy subjects can exhibit clinical changes at hemoglobin levels between 5 and 7 g/dL.

Normal Haemoglobin levels are:

- Men: 13.8 to 18.0 g/dL (138 to 180 g/L, or 8.56 to 11.17 mmol/L)
- Women: 12.1 to 15.1 g/dL (121 to 151 g/L, or 7.51 to 9.37 mmol/L)
- Children: 11 to 16 g/dL (111 to 160 g/L, or 6.83 to 9.93 mmol/L)
- Pregnant women: 11 to 14 g/dL (110 to 140 g/L, or 6.83 to 8.69 mmol/L) (9.5 to 15 usual value during pregnancy)

Dehydration or hyperhydration can greatly influence measured hemoglobin levels. Albumin can indicate hydration status.

Elderly patients, however, can respond to and tolerate preoperative anemia differently than younger patients. In one study of twenty patients above the age of 65 and free from known cardiac disease, isovolemic anemia to a mean hemoglobin level of 8.8 g/dL was well tolerated. Another study examined patients who had known coronary artery disease and found that isovolemic anemia was well tolerated to hemoglobin level of 9.9 g/dL. In addition, the increase in cardiac index plus oxygen extraction during hemodilution was found to be independent of age. The results of this studies should be interpreted with caution as they involved small numbers of patients and very few were above the age of 80 years. A more recent study compared preoperative hematocrit levels in over 310,000 elderly veterans undergoing noncardiac surgery. In contrast to their two previous studies, even mild anemia was

associated with an elevated risk of thirty-day morbidity and mortality. There was a monotonical rise in mortality and cardiac events while the hematocrit level was less than 39%. These results, however, may be unable to be generalized to elderly females. Moreover, it is unclear whether the anemia is causal or associated with the elevated morbidity and mortality, and whether this risk may be corrected with blood transfusion.

There have been many observational trials documenting the effect of anemia and red blood cell transfusions on clinical outcomes of patients having surgery, those with acute coronary syndromes, and those admitted in intensive care units. With the exception of three studies, the risks of blood transfusion appeared to outweigh the benefits. Transfusion was associated with an elevated risk of death, infection, multiorgan dysfunction syndrome, and acute respiratory distress syndrome. But, this analysis has important limitations including that the analysis did not take into account the hemoglobin level before transfusion and very high likelihood of uncontrolled confounding. Patients requiring blood transfusions are more severely ill than the patients that do not require the transfusion and it is impossible to completely adjust for these differences between those patients who have received transfusions and those who have not. Therefore, the decision to transfuse blood in a preoperative patient must rest on the condition of the individual patient.

In the case of iron deficiency anemia, the basic cause, such as blood loss, should be identified and treated. Therefore, a thorough gastrointestinal tract evaluation is often indicated. The supplementation of iron, however, must also be initiated. Iron is most easily given in the oral form, the least expensive of which was ferrous sulfate. Ferrous sulfate provides 65 mg of elemental iron per 325 mg tablet. It has been recommended that adults receive 150 to 200 mg of elemental iron per day in deficiency states. Peroral iron is more

readily absorbed in an acidic gastric environment and, therefore, often given along with ascorbic acid and while avoiding antacids. Reticulocytosis is generally observed in seven to ten days, and the hemoglobin level should increase by 1 g/dL every two to three weeks. Those patients have failed oral iron therapy, or if iron loss exceeds capacity of oral iron absorption, intravenous iron therapy may be necessary. Common clinical scenarios where this occurs include patients with inflammatory bowel disease, intestinal malabsorption due to celiac disease, patients intolerant to oral iron therapy, or patients undergoing cancer chemoradiation. Of the intravenous iron preparations ferric gluconate and iron sucrose are usually thought to have the best safety profile. Recent studies and systematic reviews, however, suggesting that low-molecular-weight iron dextran may have a comparable toxicity profile with iron sucrose.

Anemia due to vitamin B12 or folate deficiency can also be easily treated with supplementation. Folate deficiency must be treated with folic acid, 1 mg per day for up to four months, or until the patient's anemia gets corrected. Vitamin B12 deficiency is usually treated with intramuscular cobalamin injections. The dose of cobalamin may vary depending on the severity of the anemia and symptoms, starting 1000 mcg daily for seven days, to 1000 mcg every one to four weeks. Studies have also suggested that oral cobalamin supplementation of 1000-2000 mcg per day for four months, can be at least as effective as parenteral cobalamin, but this requires better patient compliance. Reticulocytosis may be expected in three to five days, and hemoglobin levels should increase within ten days.

Patients with anemia of chronic disorder, chronic renal insufficiency, zidovudine-treated HIV-infected patients and other hematological disorders may benefit from use of erythropoietin prior to surgery. In many patients erythropoietin can raise the hemoglobin concentration enough to reduce the need for allogeneic patient blood transfusion after surgery.

The target hemoglobin concentration must be no greater than 12 g/dL to avoid potential risks associated with erythropoietin (i.e., thromboembolism, severe cardiovascular events, and mortality), and all patients should received thromboembolism prevention.

A special mention must be made about preoperative transfusions in patients with sickle cell disease, as the perioperative complication rate of this patient population can be as high as 67%. Surgical stress and trauma can elevate the rate of anemia and sickle cell formation, and red cell transfusions are often used to preserve oxygen-carrying ability and to dilute the sickle cells and thus transfusion-related complications are twice as likely.

It is recommended to carefully evaluating each patient's symptoms and signs and not basing the blood transfusion decision solely on a hemoglobin concentration. Those patients who are symptomatic because of their anemia should be transfused as needed. The optimal rate of red blood cell administration should be guided by the clinical situation. Active exsanguination may need transfusion rates as high as five to ten units of red cells over ten to fifteen minute, but, those patients at risk for volume overload should be transfused at one mL/kg/hour. Most patients can be transfused at one unit of red cells every one to two hours, and a hemoglobin level increase of 1 g/dL should be expected per unit of red cells transfused. After each red blood cell unit is transfused, a repeat hemoglobin level should be obtained, and the patient must be reevaluated.

Anemia produces a unique set of challenges in the preoperative patient. An efficient evaluation of anemia relies on a detailed history as well as physical examination and a systematic approach to the diagnostic testing. The occurrence of anemia, as well as the use of perioperative blood transfusions, has significant ramifications on the surgical outcome. While the current evidence suggests a lower blood transfusion threshold may be appropriate in most

preoperative patients, the decision to transfuse blood must be individualized to the patient and the clinical setting.

SURGICAL TRAUMA AND THE STRESS RESPONSE

The neuroendocrine, metabolic and inflammatory effects of injury are part of the overall ‘stress response’. This has been studied most widely in relation to surgery, because the catabolic changes that occur can be observed from a well-described starting point, but similar features occur in trauma, burns, severe infection and also in strenuous exercise. These result in substrate mobilization, muscle protein loss and sodium and fluid retention, with suppression of anabolic hormone secretion. There is activation of the autonomic nervous system and immunological and haematological changes. Generally, the extent of the metabolic response is proportional to the severity of the surgical trauma. These alterations have probably evolved to aid survival in a more primitive environment, by mobilizing substrates, reducing tissue damage, destroying infectious organisms and activating repair functions. Psychological and behavioural changes accompany the physiological events. The advantages of the stress response are not obvious in modern medicine, when physiological changes may be more easily corrected and it may even have a detrimental effect. Recently, research has focused on methods to modify the response associated with surgery in an attempt for improving patient outcome.

Surgery evokes a series of hormonal and metabolic alterations commonly referred to as the stress response. There is increased secretion of pituitary hormones along with activation of the sympathetic nervous system. Increased catabolism mobilizes substrates for providing energy. Salt and water retention occur for maintaining fluid volume and cardiovascular homeostasis.

Attempts have been made to modify the stress response post surgery with various anaesthetic techniques but these results are inconclusive.

Initiation of response

The hypothalamic–pituitary axis and the autonomic (sympathetic) nervous system are activated by afferent nerve input, both somatic and also autonomic, from the area of trauma or injury. There is a failure of the normal feedback loops of control of hormone secretion. For example, enhanced cortisol secretion fails to prevent further production of adrenocorticotrophic hormone (ACTH). In general, there is release of catabolic hormones like the catecholamines and pituitary hormones whereas anabolic hormones like insulin and testosterone are suppressed. Catecholamines are released from the adrenal medulla causing norepinephrine spills over from presynaptic nerve terminals responding to hypothalamic stimulation. Marked activation of the sympathetic nervous system resulting in tachycardia and hypertension. Hepatic, pancreatic and renal function are also modified. Renin is released from the kidneys leading to the conversion of angiotensin I to angiotensin II. The latter induces the secretion of aldosterone from the adrenal cortex, which in turn causes elevated sodium reabsorption from the distal convoluted tubule in the kidney. Glucagon released from endocrine pancreas stimulates the breakdown of glycogen in the liver and muscle leading to elevated glucose and lactate concentrations as well as mobilization of free fatty acids (FFAs) from available fat stores. However, the effects of insulin on fat and carbohydrate metabolism are much more significant.

Pituitary gland

The anterior pituitary gland is regulated by hypothalamic releasing or inhibiting factors, which are secreted into the hypothalamic–hypophyseal portal system. The hypothalamus has direct neural control of the posterior pituitary gland. This secretion of the anterior pituitary hormones ACTH and growth hormone (GH) is stimulated by hypothalamic releasing factors, corticotrophin releasing factor (CRF) along with somatotrophin (or growth hormone releasing factor). The secretion of prolactin is within tonic inhibitory control via prolactin release inhibitory factor; perioperative elevated prolactin secretion occurs by release of inhibitory control. The secretion of various hormones, thyroid stimulating hormone (TSH), luteinizing hormone (LH) and follicle stimulating hormone (FSH) will not change significantly. Increased arginine vasopressin (antidiuretic hormone) released from the posterior pituitary, in addition to CRF, stimulates the production of the active amino acid pro-opiomelanocortin in the anterior pituitary, which is the precursor molecule of ACTH, β-endorphin and N-terminal precursor. ACTH stimulates cortisol production in a few minutes of the start of surgery. The production of ACTH is far in excess of what is required to produce a maximum adrenocortical response. The normal baseline value of cortisol is ~400 nmol litre−1, that can increase to >1500 nmol litre−1 within 4–6 h of major surgery starting. The normal negative feedback mechanism fails and concentrations of ACTH and cortisol remains consistently increased. The magnitude and duration of the increase correlate well with the severity of an insult and the response is not abolished by the administration of steroids. The metabolic effects of cortisol are enhanced with skeletal muscle protein breakdown to supply gluconeogenic precursors and amino acids for protein synthesis in the liver, and stimulation of fat lysis. Glucose utilization is impaired, which is known as an ‘anti-insulin effect’ causing

further hyperglycaemia. There are also mineralocorticoid effects with sodium and fluid retention and potassium loss. Cortisol also has well recognized anti-inflammatory effects regulated by a decrease in production of inflammatory mediators such as leukotrienes, cytokines as well as prostaglandins.

Growth hormone has mixed catabolic as well as anabolic effects but increased secretion after surgery has only a minor physiological role but its diabetogenic effects are not thought to be important in the perioperative period. Glycogenolysis as well as lipolysis are promoted by GH while glucose uptake and utilization by tissues are inhibited. However, it may have a more important role in helping to prevent skeletal muscular protein breakdown and promote tissue repair. This action is achieved by the stimulation in the production of polypeptides in the liver, which are known as somatomedins also called insulin-like growth factors (IGFs). The main protein is somatomedin C (or IGF-1), that reduces protein catabolism. There has been considerable interest in the significant role of recombinant growth hormone or IGFs in improving wound healing, but evidence is not conclusive. β-Endorphin is a peptide produced from the amino acid pro-opiomelanocortin and increased concentrations during surgery suggest anterior pituitary stimulation.

Arginine vasopressin - The increased production of this hormone from the posterior pituitary has an anti-diuretic effect. It is also an important vasopressor and enhances haemostasis. ACTH release is enhanced by AVP.

Insulin and glucagon - Insulin is a key anabolic hormone which is usually secreted in response to hyperglycaemia promoting glucose utilization and glycogen synthesis. Lipolysis is inhibited and muscle protein loss reduced. The failure of the body to secrete insulin in response to trauma is partly caused by the inhibition of the β-cells in the pancreas by the α2-adrenergic

inhibitory effects of catecholamines. ‘Insulin resistance’ by target cells occurs later because of a defect in the insulin receptor/intracellular signalling pathway. Thus, the perioperative period is characterized by a state of functional insulin deficiency. In contrast to insulin, glucagon release promotes hepatic glycogenolysis and gluconeogenesis, but insulin effects predominate. Glucagon secretion increases briefly during surgery but it is not thought to make a major contribution to the hyperglycaemia.

Other hormones

Thyroxine (T4) and tri-iodothyronine (T3) are secreted by the thyroid, in response to TSH. T3 is five times more active than T4. They are highly bound in the circulation to albumin, thyroxine-binding pre-albumin and thyroid-binding globulin. They stimulate oxygen consumption in many organs, increase the metabolic rate and heat production. Circulating concentrations are inversely correlated with sympathetic activity and after surgery there is a reduction in thyroid hormone production, which returns to normal over a few days. The importance of the changes in gonadotrophin production and testosterone after surgery is uncertain. Testosterone concentrations are decreased for several days as are oestrogen values in females.

The overall metabolic effect of the endocrine response is the mobilization of substrates from carbohydrate, lipid and protein stores. Hyperglycaemia is a major feature of the metabolic response to surgery and results from an increase in glucose production, at the same time as a reduction in glucose utilization. This is facilitated by catecholamines and cortisol, which promote glycogenolysis and gluconeogenesis. The hyperglycaemic response is enhanced by the iatrogenic effects of administration of glucose infusions and blood products. The usual mechanisms, which regulate glucose production and homeostasis, are ineffective because of

initial failure of insulin secretion followed by insulin resistance. The size of the hyperglycaemic response reflects the severity of surgery or injury. Glucose concentrations >12 mmol litre−1 impair wound healing and increase infection rates. There is also an increased risk of ischaemic damage to the nervous system and myocardium.

Initially there is inhibition of protein anabolism, followed later, if the stress response is severe, by enhanced catabolism. Protein catabolism is stimulated by increased cortisol and cytokine concentrations. The amount of protein degradation is influenced by the type of surgery and also by the nutritional status of the patient. For example, after major abdominal surgery, up to 0.5 kg day−1 of lean body mass may be lost, which can cause significant muscle wasting and weight loss. Skeletal muscle protein is mainly affected but some visceral muscle protein may also be catabolized to release essential amino acids. The amino acids released form new proteins in the liver known as acute phase proteins, but albumin production is reduced interfering with the maintenance of the extracellular volume. Amino acids are also used for gluconeogenesis to maintain circulating blood glucose >3 mmol litre−1. The amount of protein loss can be assessed indirectly by measuring nitrogen excretion in the form of urea in the urine. Attempts to prevent protein loss after surgery, by providing nutritional support, enteral and parenteral, have proved disappointing. The availability of additional substrates has little effect in overcoming the inhibition of protein anabolism and preventing catabolism.

Increased catecholamine, cortisol and glucagon secretion, in combination with insulin deficiency, promotes lipolysis and ketone body production. Triglycerides are metabolized to fatty acids and glycerol; the latter is a gluconeogenic substrate. High glucagon and low insulin concentrations also promote oxidation of FFAs to acyl CoA. Acyl CoA is

converted in the liver to ketone bodies (β-hydroxybutyrate, acetoacetate and acetone), which are a useful, water-soluble fuel source. Heparinization (for example during cardiac surgery) activates lipoprotein lipase which stimulates lipolysis, but this is less of a problem with the new 'cleaner' heparins.

Salt and water metabolism - Arginine vasopressin secretion results in water retention, concentrated urine, and potassium loss and may continue for 3–5 days after surgery. Renin is secreted from the juxtaglomerular cells of the kidney secondary to sympathetic efferent activation. It converts angiotensin to angiotensin II, which in turn releases aldosterone from the adrenal cortex promoting sodium and water retention from the distal convoluted tubule.

Cytokines - Cytokines are low molecular weight, heterogeneous glycoproteins that include interleukins (IL) 1–17, interferons, and tumour necrosis factor. They are synthesized by activated macrophages, fibroblasts, endothelial and glial cells in response to tissue injury from surgery or trauma. Although they exert most of their effects locally (paracrine), they can also act systemically (endocrine). Cytokines play an important role in mediating immunity and inflammation by acting on surface receptors of target cells.

The most important cytokine associated with surgery is IL-6 and peak circulating values are found 12–24 h after surgery. The size of IL-6 response reflects the degree of tissue damage which has occurred. IL-6, and other cytokines, cause the acute phase response (Table 3), which includes the production of acute phase proteins such as fibrinogen, C reactive protein, complement proteins, α2-macroglobulin, amyloid A and ceruloplasmin. Other effects of cytokines include fever, granulocytosis, haemostasis, tissue damage limitation and promotion of healing. The immune system and neuroendocrine system are closely related. Cytokines may increase the release of cortisol although this has only been demonstrated in

vitro and cytokine production is limited by cortisol in a negative feedback system. Thus, the cortisol response to surgery limits the severity of the inflammatory response.

Refining surgical techniques may have some benefit in reducing the inflammatory responses. Cytokine release is reduced in less invasive surgery such as laparoscopic techniques leading to quicker recovery and discharge. Nutrition can also play a major part in preventing the adverse effects of the stress response. Enteral feeding, in particular immunonutrition (glutamine, arginine, omega-3 fatty acids) has been shown to improve recovery. There may also be a role for growth hormone and anabolic steroids in improving outcome. Insulin infusions, with and without glucose, may also reduce excess protein breakdown. Maintenance of normothermia is also beneficial in reducing the extent of the metabolic response to surgery.

The hormonal and metabolic response to surgical and other physiological stresses is complex. It is important to reduce the deleterious effects of hypertension and tachycardia during surgery, particularly in patients with ischaemic heart disease. Modern anaesthetic practice strives to suppress sympathetic responses and maintain cardiovascular stability. However, there is no consistent method of suppressing the endocrine and metabolic changes and even when this is possible it is uncertain whether this benefits long-term outcomes.

PROTEIN

Proteins are essential nutrients for the human body. They are one of the building blocks of body tissue, and can also serve as a fuel source. As a fuel, proteins provide as much

energy density as carbohydrates: 4 kcal (17 kJ) per gram; in contrast, lipids provide 9 kcal (37 kJ) per gram.

The amount of protein required in a person's diet is determined in large part by overall energy intake, the body's need for nitrogen and essential amino acids, body weight and composition, rate of growth in the individual, physical activity level, individual's energy and carbohydrate intake, as well as the presence of illness or injury. Physical activity and exertion as well as enhanced muscular mass increase the need for protein. Requirements are also greater during childhood for growth and development, during pregnancy or when breast-feeding in order to nourish a baby, or when the body needs to recover from malnutrition or trauma or after an operation. If not enough energy is taken in through diet, as in the process of starvation, the body will use protein from the muscle mass to meet its energy needs, leading to muscle wasting over time. If the individual does not consume adequate protein in nutrition, then muscle will also waste as more vital cellular processes (e.g. respiration enzymes, blood cells) recycle muscle protein for their own requirements. Protein Energy Malnutrition is predominantly seen in hospitals, is associated with disease, or is often found in the elderly.

GASTROINTESTINAL ANASTOMOSIS

Gastrointestinal anastomosis is a surgical procedure to establish communication between two formerly distant portions of the gastrointestininal tract. This procedure restores gastrointestinal continuity after removal of a pathologic condition affecting the bowel.

Indications

Indications for intestinal anastomosis can be broadly divided into two categories:

1. Restoration of bowel continuity following resection of diseased bowel and

2. Bypass of unresectable diseased bowel.

Certain pediatric conditions may also require intestinal anastomosis.

Resection of diseased bowel is performed in the following settings:

- Bowel gangrene due to vascular compromise caused by mesenteric vascular disease, prolonged intestinal obstruction, intussusceptions, or volvulus
- Malignancy
- Benign conditions (eg, intestinal polyps, intussusception, roundworm infestation with intestinal obstruction)
- Infections (eg, tuberculosis complicated with stricture or perforation)
- Traumatic perforations
- Large perforations (traumatic) not amenable to primary closure
- Radiation enteritis complicated with bleeding, stricture, or perforation
- Inflammatory bowel disease, ulcerative colitis, or Crohn disease that is refractory to medical therapy or associated with complications (eg, bleeding, perforation, toxic megacolon, dysplasia/carcinoma)
- Chronic constipation, idiopathic slow transit constipation, or Hirschsprung disease: Subtotal colectomy may be performed when the disease is refractory to medical therapy

Bypass of unresectable diseased bowel is performed in following settings:

- Locally advanced tumor causing luminal obstruction
- Metastatic disease causing intestinal obstruction
- Poor general condition or condition that prevents major resection

Pediatric conditions for which intestinal anastomosis may be required include the following:

- Congenital anomalies (eg, Meckel diverticulum, intestinal atresia, malrotation with volvulus leading to gangrene, meconium ileus, duplication cysts, Hirschsprung disease)
- Inflammatory conditions (eg, necrotizing enteritis, enterocolitis, tuberculosis, enteric perforation)
- Other conditions (eg, intussusception, angiodysplasia, polypoid disease, ascariasis)
- As a part of other surgical procedures (eg, Kasai portoenterostomy, choledochal cyst, urinary diversions, pancreatic neoplasms)

Contraindications

Contraindications to intestinal anastomosis include conditions in which there is high risk of anastomotic leak, such as the following:

- Severe sepsis
- Poor nutritional status (eg, severe hypoalbuminemia)
- Disseminated malignancy (multiple peritoneal and serosal deposits, ascites)
- Viability of bowel in doubt
- Fecal contamination or frank peritonitis
- Unhealthy bowel condition - Precludes primary anastomosis

Perioperative management

Perioperative management includes the following:

- Preoperative fluid resuscitation
- Preoperative antibiotic prophylaxis
- Placement of nasogastric tube and indwelling urinary catheter
- Venous thromboembolism prophylaxis

Operative techniques

Adequate exposure and access, gentle handling of the bowel, adequate hemostasis, approximation of well-vascularized bowel, absence of tension at anastomosis, good surgical technique, and avoidance of fecal contamination are tenets of good intestinal anastomosis.

The image below depicts a completed small-bowel anastomosis

Surgical techniques used in intestinal anastomosis include the following:

- Incision and exposure
- Bowel resection
- Hand-sewn anastomosis (eg, bowel anastomosis, gastrojejunostomy, colorectal anastomosis, esophagogastric anastomosis)
- Stapled anastomosis (eg, gastrojejunostomy, small bowel anastomosis, colorectal anastomosis, cervical esophagogastric anastomosis)

Postoperative complications

Important complications following intestinal anastomosis include the following:

- Anastomotic leak
- Bleeding
- Wound infection
- Anastomotic stricture
- Prolonged functional ileus, especially in children
- Intestinal anastomosis is a surgical procedure to establish communication between two formerly distant portions of the intestine. This procedure restores intestinal continuity after

removal of a pathologic condition affecting the bowel. Intestinal anastomosis is one of the most commonly performed surgical procedures, especially in the emergency setting, and is also commonly performed in the elective setting when resections are carried out for benign or malignant lesions of the gastrointestinal tract.

- A disastrous complication of intestinal anastomosis is anastomotic leak resulting in peritonitis, which is associated with high morbidity and mortality. Proper surgical technique and adherence to fundamental principles is imperative to ensure successful outcome after intestinal anastomosis.
- Intestinal anastomosis can be performed by means of a hand-sewn technique that uses absorbable or nonabsorbable sutures or by means of stapling. The former is the more commonly used option because of the availability and affordability of suture materials and the wide familiarity with the procedure. The increased availability of stapling devices for intestinal anastomosis has provided an alternative option to perform a rapid anastomosis. Higher cost, limited availability, and less familiarity are the main drawbacks of these devices. Less common techniques for intestinal anastomosis use compression devices (biofragmentable anastomotic rings), glue (tissue or synthetic), and laser welding.

Procedural planning

Although an inverting anastomosis has been found to be better than an everting anastomosis, there is no difference in complication rates between single-layer and double-layer techniques or between continuous and interrupted anastomosis.

Stapled anastomotic technique has virtually replaced hand-sewn technique for low colorectal anastomosis, and its use in other areas has also increased. Although stapled anastomosis has

not yet been proved superior to hand-sewn anastomosis, it has definitely reduced the operating time and facilitated the ease of doing the procedure, especially in low colorectal anastomosis.

Although restoration of bowel continuity is generally preferred, a decision has to be made judiciously in emergency settings. A staged procedure may be preferred for restoration of bowel continuity if the general condition of the patient is not good enough to avoid the complications associated with anastomotic leak.

Complication prevention

An important component of preventing complications related to intestinal anastomosis is to complete preoperative optimization of patients' medical status, including correction of malnutrition with nutritional support and treatment of associated systemic illness. However, this is generally possible only in elective resections, not in emergency situations.

The following can also help prevent complications:

- Adequate exposure and access
- Gentle handling of the bowel
- Adequate hemostasis
- Approximation of well-vascularized bowel
- Absence of tension at anastomosis
- Good surgical technique
- Avoidance of fecal contamination

It is very important to prevent hypothermia and hypovolemia during surgery, especially in children. Thermal mattresses should be used for thermoregulation, especially for neonates.

Fluid loss should be minimized and losses should be adequately replaced. Adequate blood should be arranged.

Preprocedural Planning

Preoperative fluid resuscitation to optimize hydration status is imperative because patients who present in emergency settings are frequently dehydrated.

Preoperative antibiotic prophylaxis is a must to prevent infective complications in emergent settings, as well as some elective settings when associated with a major surgical procedure.

A nasogastric tube and indwelling urinary catheter should be inserted to decompress the stomach and the urinary bladder, respectively. Decompression of the stomach reduces the risk of aspiration of gastric contents during induction of anesthesia.

Traditionally, mechanical bowel preparation is given before elective colorectal procedures to prevent anastomotic complications. However, there is now evidence in the literature to suggest that mechanical bowel preparation does not have any beneficial effect on the complication rate; in fact, it might have a detrimental effect on healing by causing immune changes in colonic mucosa that interfere with the healing process.

Venous thromboembolism prophylaxis is a must to prevent deep vein thrombosis of lower limbs and possibly mesenteric venous thrombosis in high-risk patients (thrombophilic state).

Equipment

Intestinal anastomosis is performed in an operating room, which should be equipped with the following:

- Anesthetic equipment, overhead lights, and an operating table that is preferably power-controlled to ensure smooth and accurate positioning for various surgical procedures, electrodiathermy, and suctioning systems
- Appropriate laparoscopic instruments and monitors (preferably high-definition) if laparoscopic resection and anastomosis is contemplated
- Double-lumen endotracheal tube with single-lung ventilation is required for thoracotomy/thoracoscopic esophagectomy and anastomosis
- All types of suture materials (absorbable/nonabsorbable, monofilament/multifilament) used for intestinal anastomosis
- Stapling devices commonly used for intestinal anastomosis, such as a transverse anastomosis (TA) stapler, gastrointestinal anastomosis (GIA) stapler, and circular end-to-end anastomosis (EEA) stapler (if stapled intestinal anastomosis is planned)

Anesthesia

Intestinal anastomosis is performed with the patient under general anesthesia. A double-lumen endotracheal tube with single-lung ventilation is required for thoracotomy/thoracoscopic esophagectomy and anastomosis. Patients who are anesthetized for emergency surgery (eg, for intestinal obstruction or gangrene gut) are at greater risk for aspiration of gastric contents. The risk of aspiration can be reduced by emptying the stomach before induction and by using rapid-sequence induction technique.

Positioning

Patient positioning depends upon the type of surgical procedure. Most abdominal operations are performed in the supine position with arms abducted at right angles to the body or sometimes by the side of the body. Pelvic procedures are performed with the patient in the lithotomy position.

Care should be taken to avoid excessive flexion or abduction. Adequate padding of pressure points should be ensured to avoid neurologic damage and pressure ulcerations. Esophageal procedures (requiring thoracotomy) are performed with the patient in a lateral or semiprone position. Patient positioning also must be changed during the course of operation to facilitate performance of the surgical procedure.

Approach Considerations

Preoperative nasogastric aspiration is usually required. Similarly, urinary catheterization is necessary in critically ill patients, during emergency resections, or when infraumbilical incision is used to protect the urinary bladder from injury during laparotomy.

An exploratory laparotomy may be performed. If the disorder is diagnosed preoperatively, the pathology can be identified and the part of the intestine to be resected can be isolated and excised. Continuity is restored by performing the anastomosis.

Sometimes, the resection and anastomosis of the bowel could be components of another major surgical procedure, such as a Whipple procedure, gastrectomy, urinary diversions, or resection of a retroperitoneal tumor.

Incision and Exposure

Adequate access is the key to ensuring successful intestinal anastomosis. A midline incision is commonly used for the majority of abdominal operations. The use of self-retaining retractors ensures adequate exposure. Exposure in pelvic operations can be improved by changing the position of the patient (Trendelenburg position) so as to displace small-bowel loops away from the pelvis. Packing the small bowel with wet sponges also improves exposure in pelvic procedures. A supraumbilical transverse incision is frequently used in younger children.

Bowel Resection

The portion of bowel to be resected should be adequately mobilized. Mobilization is rarely a problem with the small bowel, which can be easily brought to the surface. However, the large bowel (especially the retroperitoneal segments) should be adequately mobilized by dividing the lateral peritoneal reflection. Bowel mobilization, in addition to facilitating resection, ensures tension-free anastomosis.

After mobilization of the bowel, the next step is division of the mesentery. Principles to be followed in division of the mesentery include the following:

- Transillumination to identify mesenteric blood vessels
- Isolation of vessels by dividing surrounding fat
- Division between clamps
- Ligation with suitable sutures to prevent knot slippage

On-needle transfixation of large vascular pedicles with nonabsorbable sutures is a safer method. Bleeding or hematoma formation within the leaves of mesentery should be avoided, and preservation of vascular arcade to the bowel ends should be ensured so as to have

satisfactory vascularity of the anastomosed bowel. Alternatively, the mesentery can be divided with an ultrasonic scalpel.

The next step is division of the bowel. This is done by applying a noncrushing clamp on the bowel end used for anastomosis and applying crushing clamps on the bowel to be resected so that the intraluminal contents of the resected bowel do not contaminate the peritoneal cavity. Clamps are applied from the antimesenteric end, and care should be taken to avoid crushing of the mesentery.

The bowel is divided with a knife close to the crushing clamp so as to preserve adequate bowel length distal to a noncrushing clamp for anastomosis. The direction of division is oblique to ensure an adequate lumen and to maintain a longer length of the mesenteric end as compared to the antimesenteric end. The specimen is removed with clamps in situ.

Care should be taken to avoid spillage of enteric contents during bowel division. Alternatively, bowel division can also done with a linear cutting (gastrointestinal anastomosis [GIA]) stapler, which divides and seals two cut ends simultaneously, thereby preventing fecal contamination.

Hand-Sewn Small bowel Anastomosis

This section describes a double-layer sutured end-to-end small-bowel enteroenterostomy. Two cut ends of the bowel are brought in close apposition. Stay sutures of 3-0 silk are placed between the serosa of the proximal and distal ends of the bowel approximately 5 mm from the cut end.

Interrupted seromuscular sutures (Lembert stitches) of 3-0 silk are placed between these stay sutures with an approximately 3-mm gap between each two sutures. Lembert stitches should incorporate only the seromuscular layer; care must be taken not to incorporate the full thickness

of the bowel wall. Sutures are tied sequentially, with care taken not to apply excessive tension so as to minimize the risk of cut-through of the seromuscular layer. This forms the posterior outer layer.

Next, a Connell stitch is made in both ends. The Connell stitch is achieved by passing the suture from the outside in, then inside out, on one end. The same step is repeated on the other end in the form of a continuous U-shape. The suture is tied so that the knot is outside. The posterior inner layer is completed by taking interrupted full-thickness stitches of 3-0 polyglactin, starting from the near end. The sutures are tied sequentially so that the knot lies inside the lumen.

The needle must be pulled through each edge separately. Trying to include both edges in one pass of the needle can prevent the surgeon from taking a full-thickness bite on both edges. It is necessary to include the submucosa carefully because this is the strongest layer of the bowel wall and gives strength to the anastomosis.

The anterior inner layer is completed in a similar fashion, starting from the far end. The pouting of mucosa is prevented by taking a small amount of mucosa and a large part of the seromuscular layer, which results in inversion of the mucosa.

The anterior outer seromuscular layer is completed by taking interrupted Lembert stitches.

Narrowing of the lumen by including too much of the bowel into this layer should be avoided. Patency of the lumen can be confirmed by palpation across the anastomosis with the tips of the thumb and the index finger. The mesenteric defect is closed with interrupted stitches of 3-0 silk. Care should be taken to avoid injuring mesenteric vessels so as to prevent ischemia of the anastomotic site.

Gastrojejunostomy

This section describes the technique of gastrojejunostomy following distal gastrectomy. The first step is to bring up the jejunal loop in an antecolic position.

Interrupted Lembert seromuscular stitches of 3-0 silk are placed between the antimesenteric end of the jejunum and the posterior gastric wall. This forms the posterior outer layer. After application of a noncrushing intestinal clamp across the jejunal loop, an incision is made in the jejunum with a knife approximately 5 mm lateral to the seromuscular stitches.

The size of the jejunal opening should be slightly smaller than the gastric opening because the small bowel tends to stretch while taking sutures. Two Babcock clamps are placed (one on each anterior wall) to expose the posterior gastric and jejunal walls.

The posterior inner layer is started by making a Connell stitch at the near end with 3-0 polyglactin. The suture is tied so that the knot lies outside the lumen, and the free end of the thread is kept long and held with a hemostat. After the lumen is entered from the outside in with the needle end of the suture, full-thickness continuous interlocking stitches are taken through both edges. The needle must be pulled through each edge separately to ensure a full-thickness bite on both edges. This forms the posterior inner layer.

Once the far end is reached, a Connell stitch is made, and the anterior inner layer is completed by taking continuous interlocking through-and-through stitches. A loop-on-mucosa suture technique is followed, in which the suture is taken from the inside out of the jejunal wall and outside in through the stomach wall, with the pull on the suture being within the lumen. This ensures good inversion of the mucosa (see the image below).

Good inversion of the mucosa is also ensured by taking a small amount of mucosa and a large part of the seromuscular layer. Once half of the anterior inner layer is completed, clamps are

released to ensure the absence of bleeding in the posterior layer. If bleeding points are identified, they are controlled by taking interrupted full-thickness stitches through both edges.

The anterior inner layer is completed by tying the free end of the thread on the near end. The double-layer anastomosis is completed with an anterior seromuscular layer of interrupted 3-0 silk sutures.

Colorectal anastomosis

Reconstruction after an anterior resection can be performed in either an end-to-end or a side-to-end fashion. A side-to-end technique (Baker anastomosis) is preferred when there is a size discrepancy between two bowel ends. This section describes the technique of end-to-end hand-sewn colorectal anastomosis following anterior resection.

Two bowel ends with right-angle clamps in situ are brought close by applying lateral seromuscular traction sutures of 3-0 silk. The anastomosis is performed in a single layer with 3-0 silk. Posterior interrupted full-thickness sutures are taken from the distal rectum to the proximal sigmoid colon. Sutures are not tied but are held long with a hemostat. This ensures accurate placement of full-thickness sutures.

After completion of the posterior layer, sutures are tied in order, starting from one corner. While one suture is being tied, the next suture should be held taut by an assistant to ensure that there is no abnormal gap between the two sutures. Next, full-thickness interrupted anterior-layer sutures are taken, following principles similar to those adopted for the posterior layer.

Sutures are then tied to complete the anastomosis. The integrity of the anastomosis can be checked by filling the pelvis with saline and instilling air through the anus to look for any air bubbles. Transanal anastomosis has also been described after total mesorectal excision.[9, 10]

Esophagogastric anastomosis

The characteristic feature of the esophageal anatomy is the unusually fatty submucosa, which allows greater mobility of the overlying mucosa. In performing an esophageal anastomosis, care should be taken to ensure that every suture transfixes the mucosal edge, which can retract more than 1 cm from the cut esophageal margin. The esophagus also lacks a serosal layer, so that the soft and often tenuous muscle holds sutures poorly. This section describes the technique of two-layer end-to-side esophagogastric anastomosis using 3-0 silk.

The outer posterior layer uses interrupted stitches between the muscular layer of the esophagus and the seromuscular layer of the stomach. Initially, sutures are placed without being tied. During tying, care should be taken to draw the stomach towards the esophagus because the muscular layer of the esophagus holds sutures poorly. Corner ties are left long and held with a hemostat.

The posterior inner layer uses interrupted stitches left long without tying. The mucosa should be identified and included in each stitch to achieve mucosal apposition and avoid anastomotic leak. Sutures are then tied sequentially so that the knot lies inside the lumen. At this stage, the nasogastric tube is passed from the esophagus into the stomach and fixed by the anesthetist to the patient's nose.

The anterior inner layer is completed in a similar fashion, with care taken to include mucosa. The sutures are tied so that the knot lies outside the lumen.

Anastomosis is completed by taking the anterior outer layer of interrupted stitches between the muscular layer of the esophagus and the seromuscular layer of the stomach.

A single-layer esophagogastric anastomosis also can be fashioned with interrupted silk sutures. Before the anastomosis is performed, the stomach can be hitched to the prevertebral fascia with interrupted silk sutures so that it does not slide down with peristalsis.

Stapled Small bowel Anastomosis

A stapled small-bowel anastomosis can be performed in either an end-to-end (anatomic or functional) or a side-to-side fashion. True anatomic end-to-end small-bowel anastomosis is performed with a noncutting linear stapler. An important prerequisite for this type of anastomosis is that there should not be any disparity in size between the two bowel ends.

The first step is to triangulate the bowel ends by placing three traction sutures. The linear stapler is placed between two of the sutures and fired. The same process is repeated twice on the other two sides of the triangle by rotating the bowel. Any excess tissue remaining after the firing of the stapler is removed. This technique results in an everting anastomosis. Potential drawbacks of this technique are the possible anastomotic site stricture and ischemic damage secondary to an injury of mesenteric blood vessels when staples are applied close to the mesenteric end.

However, stapled small-bowel anastomosis is commonly performed in a functional end-to-end fashion by using a linear cutting stapler. In this technique, two cut ends of the bowel are placed side to side. The two forks of the stapling device are placed through open bowel ends or an enterotomy (made in the antimesenteric border if the bowel ends are stapled). Care should be taken to avoid inclusion of the mesentery between branches of the stapler. The stapler is fired to create lumen between two bowel segments by dividing the two bowel walls. The bowel ends or enterotomy can be closed by applying a linear stapler or using a hand-sewn technique.

Bleeding from stapled edges is better controlled by taking underrunning sutures. Care should be taken to avoid application of cautery to the stapled edge; doing so can result in transmission of electric current to the rest of the bowel, resulting in thermal damage.

Gastrojejunostomy

This section describes the technique of stapled gastrojejunostomy following subtotal gastrectomy. Resection of the stomach is carried out with a linear cutter so that the cut end is excised and simultaneously stapled.

After completion of the gastrectomy, the jejunal loop is brought up in an antecolic or retrocolic fashion. Seromuscular interrupted stay sutures of 3-0 silk are placed between the posterior gastric wall close to the greater curvature and the jejunal wall to bring them in apposition. A small gastrotomy and enterotomy are made to facilitate the passage of a 55-mm linear cutting (GIA) stapler.

The two limbs of the GIA stapler are placed simultaneously into the stomach, with the cartridge fork of the linear cutter inside the stomach. Care should be taken not to include part of the small-bowel mesentery. The stapler is fired so that the common wall between the stomach and the jejunum is divided and the gastrojejunostomy created.

The nasogastric tube can be either placed in the stomach or advanced into the efferent jejunal loop if early enteral feeding is planned. The enterotomy and gastrotomy can be closed with an appropriately sized linear stapler or in two layers, with the inner continuous layer using 3-0 polyglactin and the outer interrupted layer using 3-0 silk.

Colorectal anastomosis

A stapled colorectal anastomosis following anterior or lower anterior resection for carcinoma of the rectum can be performed in either an end-to-end or an end-to-side fashion. This section describes the technique of an end-to-end double-stapled colorectal anastomosis.

After mobilization of the splenic flexure, proximal division of colon is performed at the junction of the sigmoid and descending colon. Bowel division can be performed by using a 55-mm linear transverse anastomosis (TA) stapler or cutting with a knife after applying a bowel clamp.

After complete mobilization of the rectum, a right-angle clamp is applied distal to the tumor, and the distal rectum is divided with a linear stapler (30-mm or 45-mm contour device or roticulator) applied distal to the right-angle clamp. An adequate distal mural margin (2 cm) is necessary to prevent recurrence. The distal rectal stump can be washed with saline or dilute povidone-iodine to destroy exfoliated tumor cells shed in the distal rectum before a clamp or stapler is applied.

After division of the distal rectum, the bowel ends are prepared for a double-stapled anastomosis using a circular stapler (31-mm or 33-mm end-to-end anastomosis [EEA] stapler). The proximal bowel is prepared by applying full-thickness purse-string stitches of 3-0 silk or polypropylene. The anvil head is placed in the proximal colon, and the purse-string suture is tied above the tying notch.

After gentle dilatation of the anus, the shaft of the circular EEA stapler is advanced through the anal canal under the guidance of the abdominal surgeon and placed close to the staple line with the trocar fully retracted inside. The trocar is then fully extended so as to pierce the tissue and advance through the rectal wall, either anterior or posterior to the staple line. The detachable

head assembly is then reattached by sliding the anvil shaft over the trocar and pushing until the detachable head assembly snaps with the trocar into its fully seated position.

The ends of the circular stapler are closed, with care taken to confirm that there is no twist in the mesentery of the proximal colon. The stapler is tightened completely, fired, and then gently removed by rotating it counterclockwise for half a turn before removal. The presence of two intact donuts should be confirmed.

The integrity of the anastomosis should be checked by filling the pelvis with saline, instilling air in the distal rectum, and looking for air bubbles. If donuts are not complete, additional sutures should be made. In some cases, proximal diversion with proximal colostomy or ileostomy may be considered.

Cervical esophagogastric anastomosis

This section describes the technique of stapled cervical esophagogastric anastomosis popularized by Orringer. After removal of the tumor-bearing segment of the esophagus and division of the proximal esophagus, the gastric tube is brought into the neck. A 1.5- to 2-cm-long anterior vertical gastrotomy is made for passage of stapler.

The site for the gastrotomy is selected by approximating the divided end of the esophagus against the anterior gastric wall. It should be low enough to facilitate subsequent placement of a 3-cm-long stapler cartridge.

The esophagus is aligned to the stomach by placing two stay sutures. The first suture is the full-thickness stitch through the anterior corner of the esophagus. The second is the full-thickness stitch through the upper end of the gastrotomy (inside out) to the posterior corner of the divided esophagus (outside in). A GIA stapler (30 mm) is inserted simultaneously into the stomach and

esophagus while downward traction on the sutures is maintained, with the thicker staple-bearing portion of cartridge inside the esophagus.

Two stay sutures are placed between the anterior gastric wall and the adjacent esophagus on either side of the stapler to take tension off the anastomosis. The stapler is fired so that the common wall formed by the posterior esophageal wall and anterior gastric wall is divided, creating a large esophagogastric anastomosis.

A 16-French nasogastric tube is inserted by the anesthetist and advanced across the anastomosis into the intrathoracic stomach.

The esophagotomy and gastrotomy are closed with sutures in two layers (an inner continuous layer using 3-0 or 4-0 polyglactin and an outer interrupted layer using 3-0 silk).

Complications

Important complications following intestinal anastomosis include the following:

- Anastomotic leak
- Bleeding
- Wound infection
- Anastomotic stricture
- Prolonged functional ileus, especially in children

Anastomotic leak

Anastomotic leak is the most feared early complication of intestinal anastomosis. The healing of an intestinal anastomosis is broadly divided into three phases, as follows:

- Inflammatory phase

- Fibroplasia phase
- Remodeling phase

During the inflammatory phase, the integrity of the anastomosis is dependent on mechanical strength provided by sutures. The inflammatory phase is followed by the fibroplasia phase around postoperative days 5-7; this phase is characterized by a switch from collagen degradation to collagen deposition, which gives strength to the anastomosis. Any systemic or local factor that causes delay in the transition from the inflammatory phase to the fibroplasia phase can result in poor healing and anastomotic leak.

Systemic conditions that increase the risk of anastomotic leak are anemia, diabetes mellitus, malnutrition with hypoalbuminemia, vitamin deficiencies, and steroid therapy. Local factors such as the presence of irradiated bowel, anastomosis involving disease-affected bowel, and inadequate blood flow are associated with poor healing and anastomotic leak.

Anastomotic leak presenting on postoperative day 1 or 2 is invariably due to technical reasons. Anastomotic leak secondary to interference in the normal healing mechanism usually presents around the end of postoperative week 1. Anastomotic leak can present either as frank peritonitis when the leak is uncontrolled or as localized intra-abdominal collection/abscess if the leak is controlled.

An uncontrolled leak with diffuse peritonitis is associated with high morbidity and mortality and necessitates reexploration. During repeat laparotomy, a thorough lavage of the peritoneal cavity should be carried out. In most circumstances, it is better to dismantle the anastomosis and bring out the bowel loops as a stoma. A controlled leak presenting with a localized intra-

abdominal abscess can be managed conservatively with percutaneous drainage of the abscess under imaging guidance and antibiotics.

Bleeding

Bleeding-related complications after intestinal anastomosis are common in patients with sepsis and deranged coagulopathy. Bleeding may manifest in the immediate postoperative period as hemorrhagic aspirate from the nasogastric tube, hematemesis, melena, or bleeding from an intra-abdominal drain. Patients with bleeding should be aggressively managed with correction of coagulopathy (if present) and blood transfusion. If the bleeding results in hemodynamic instability with a significant decrease in hemoglobin, urgent reexploration should be performed. Intraoperative anastomotic site bleeding is characterized by blood in the intestinal lumen distal to the anastomosis. In such circumstances, the anterior layer of the sutures is opened and both layers are examined for evidence of any bleeding.

Once the bleeding site is identified, it can be controlled with hemostatic sutures. The decision to reanastomose or to convert into a stoma depends on the general condition of the patient. Conversion to a stoma is preferred in patients who are hemodynamically unstable.

Wound infection

Wound infection occurs when there is uncontrolled spillage of intestinal contents during anastomosis. It is managed by removing a few skin sutures and ensuring proper drainage of pus. Superficial surgical site infection does not require treatment with systemic antibiotics.

Anastomotic stricture

Anastomotic stricture is a late complication of intestinal anastomosis. The risk of anastomotic stricture is marginally increased after end-to-end anastomosis, especially when the anastomosis is performed with a stapled technique. The most important risk factor for anastomotic stricture is a controlled anastomotic leak managed conservatively. This scenario is more common after cervical esophageal and colorectal anastomotic leak. Anastomotic strictures occurring in these areas can be conservatively managed with endoscopic or colonoscopic dilatation. If this fails, surgical revision might be required.

Controversies

Type of suture material: The ideal suture material is one that is easy to handle, ties without fraying, is easy to sterilize, elicits little or no inflammation, and maintains the strength of the anastomosis during the lag phase of healing. None of the currently available suture materials fulfills all of these criteria.

Absorbable suture materials that are commonly used for intestinal anastomosis include the following:

- Polyglactin
- Polyglycolic acid
- Chromic catgut

The first two elicit less inflammation than catgut does.

Silk is the most commonly used nonabsorbable suture, though it initiates an intense inflammatory reaction. Newer synthetic nonabsorbable sutures (eg, polypropylene) elicit less inflammatory reaction.

In general, in two-layer anastomoses, absorbable sutures of polyglycolic acid or polyglactin are used, with an outer seromuscular stitch of silk. In one-layer anastomoses, a nonabsorbable suture such as silk is preferred.

Single-layer vs double-layer anastomosis

Intestinal anastomosis is traditionally performed in two layers. The shortcoming of the two-layer technique is that it is somewhat tedious and time-consuming to perform. Potential advantages of the single-layer technique are that it takes less time to perform and that it costs less, though safety may be a concern. However, randomized trials and meta-analyses comparing the two techniques of intestinal anastomosis did not find increases in the rate of anastomotic leak, the incidence of perioperative complications, mortality, or the length of hospital stay with the single-layer technique.

Continuous vs interrupted sutures

An intestinal anastomosis can be fashioned by using either simple (continuous) or interrupted sutures. A continuous suture is less time-consuming to place, and the suture line is more watertight with better hemostasis. However, the entire suture line is based on a single stitch.

Animal studies have shown that anastomotic blood flow and perianastomotic oxygen tension is low after a continuous suture, resulting in impaired healing and increased complication rates. However, prospective randomized trials have failed to show any difference in complication rates between the two techniques.

Hand-sewn vs stapled anastomosis

The introduction of reliable disposable instruments has led to an increase in the use of stapling devices for intestinal anastomosis.

Important advantages of the stapled technique are the shorter operating time and the greater ease of performing the procedure, especially in low pelvic anastomoses.

Inverting vs everting anastomosis

Currently, inverted anastomosis is the most widely used technique worldwide.

The outcome of patients who undergo gastrointestinal surgery varies greatly. Factors such as the patient's age and comorbidities, the complexity of the surgical procedure and the management of postoperative recovery influence the outcome. Modern perioperative management has been improved in numerous ways over the last decade and nowadays is regarded as a highly multidisciplinary task. Because an ageing population is leading to more and more patients with multiple comorbidities being referred to surgery and because surgical procedures and multimodal treatment modalities are becoming increasingly complex, close cooperation between surgeons and anaesthesiologists (i.e. joint risk assessment) is critical for improving outcome after major gastrointestinal surgery. Internists are also frequently involved to optimise the patient's physical condition or medication.

Preoperative management

Medical history and clinical assessment

A detailed medical history and a thorough clinical assessment of the patient's physical and psychological condition are of utmost importance, as it may help to identify patient risk factors

for imminent morbidity or mortality (e.g. an unappreciated reduction of physical fitness, specific medications or newly developed medical illness). Ideally, the medical history is taken, and the assessment performed before the patient's admission to the hospital so that certain medical conditions can be optimised (e.g. stabilisation of chronic heart failure, poorly controlled diabetes mellitus or arterial hypertension). However, when surgery is required for a gastrointestinal malignancy, a thorough pre-admission assessment may not be wise because it could substantially delay surgery.

Routine diagnostic tests

Close interaction between surgeons and anaesthesiologists is critical for improving patient outcome after major gastrointestinal surgery, and risk assessment should always be joint. There are routine test results that should be available before the patient is referred to anaesthesiology consultation.

Laboratory tests

Preoperative laboratory testing should be performed for all patients prior to gastrointestinal surgery. At minimum, the testing should consist of:

- Standard blood count
- International normalised ratio
- Activated partial thromboplastin time (aPTT)
- Concentrations of sodium, potassium, creatinine and glucose

Certain procedures or clinical conditions may require additional assessments. Occasionally, a laboratory test may be required on the day of surgery (e.g. serum potassium levels after

extensive mechanical bowel preparation (MBP) or glucose levels for patients with severe diabetes mellitus). Recent data have indicated that an elevated preoperative level of brain natriuretic peptide is associated with increased cardiac morbidity after major surgery, but it remains to be seen whether this level will be routinely determined for patients with cardiac risk factors.

Electrocardiography

Preoperative 12-channel electrocardiography (ECG) allows for screening of as-yet undetected cardiac disorders. It also serves as a control should perioperative cardiac complications occur. ECG should be performed for patients who:

- Are >40 years old
- Have relevant cardiac disorders (e.g. coronary artery disease, heart insufficiency, heart rhythm disturbances or valve disorders)
- Have a pacemaker (PM) or implanted cardioverter/defibrillator (ICD)
- Have newly developed pulmonary or cardiac symptoms
- Are receiving preoperative chemotherapy or chemoradiotherapy

Although it is not routine practice, many clinicians recommend that for patients with coronary artery disease who underwent high-risk surgery, an additional ECG should be obtained immediately after surgery as well as on days 1 and 2 postoperatively.

Chest radiography: The sensitivity of conventional chest radiography to detect pathophysiologic conditions in asymptomatic patients is relatively low. However, X-ray images may always serve as a basis for comparison should perioperative complications occur.

While there is currently no recommendation for preoperative chest radiography for patients with an American Society of Anesthesiologists score 1–2, regardless of the patient's age, it is indicated for patients who:

- Suffer from severe chronic obstructive pulmonary disease
- Developed yet unknown pulmonary or cardiac symptoms
- Have gastrointestinal malignancies (screening for pulmonary metastases)

Advanced diagnostic tests

After reviewing the results of routine diagnostic tests, the anaesthesiologist will likely request additional tests for certain patients or certain medical conditions. Although not indicated for standard gastrointestinal surgery, these additional tests can help in the assessment of the potential risk for perioperative problems and complications.

Echocardiography

Preoperative echocardiography should be performed on patients who:

- Have newly occurring dyspnoea of unknown origin
- Have known heart insufficiency with symptoms of deterioration
- Have cardiomyopathy and have undergone preoperative chemotherapy with epirubicin

Carotid Doppler ultrasonography

Preoperative carotid Doppler ultrasonography should be performed on patients who:

- Had experienced transient ischemic attack (TIA) or stroke within the preceding 3 months if the episode had occurred without proper follow-up medical assessment or diagnosis

- Had experienced TIA or stroke within the preceding 3 months if symptoms of deterioration have appeared

Preoperative risk assessment

Definition of "high risk"

The definition of being "high risk" for poor outcome after surgery is nebulous, as it is influenced by many variables that vary from patient to patient and from one surgical procedure to another. The surgeon and anaesthesiologist need to jointly evaluate the potential perioperative risk for each patient and the intended procedure.

Risk scores

In an attempt to facilitate perioperative risk assessment, a variety of scoring systems have been developed that incorporate the patient's age and comorbidities and the complexity of the surgical procedure. Well-known systems include the Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity and the Estimation of Physiologic Ability and Surgical Stress score. However, both systems indicate a general risk for complications and do not specify or pinpoint any specific complication. Accordingly, their implementation into routine clinical practice has proven to be difficult. Data from our University Medical Center suggest that the subjective opinion ("gut feeling") of the surgeon is a good predictor of postoperative outcome, especially in nonemergency surgery.

More recently, a risk calculator for colorectal surgery has been developed by the National Surgical Quality Improvement Program registry of the American College of Surgeons. After a patient's variables are entered, the risk probabilities for adverse outcome are calculated.

However, only registry members can access the calculator, and it is not clear whether this US hospital-based tool is applicable to European institutions.

Cardiac risk evaluation

Overall, gastrointestinal surgery is associated with a medium cardiac risk. However, due to an ageing population, an increasing incidence of coronary artery disease and the increasing complexity of surgical procedures, postsurgical cardiac complications are now a leading cause of morbidity and mortality. Particularly cardiac insufficiency is emerging more and more as a risk factor for perioperative adverse outcome, even compared with cardiac ischemia. Comorbidities that increase the cardiac risk for patients undergoing gastrointestinal surgery include:

- Coronary artery disease
- Heart insufficiency
- Severe aortic stenosis
- Peripheral artery disease
- Cerebrovascular insufficiency
- Renal failure
- Diabetes mellitus

Because both the assessment of these cardiac risk factors and their clinical interpretation are complicated, patients with diverse cardiac risk factors, acute symptoms of a cardiac disease or reduced physical fitness should be referred for consultation with an experienced cardiologist.

Pulmonary risk evaluation

Late postoperative pulmonary complications are the second-leading cause of morbidity and mortality after major surgery. For this reason, preoperative optimisation of the patient's physical condition and medication is important. Although most of these risk factors cannot be circumvented, they must be kept under consideration.

Medication

Because the abrupt discontinuance of certain drugs may cause severe problems, a detailed medical history of the patient's medication is very important. In general, cardiovascular medication should be continued. Clear liquid intake (e.g. water or tea but not milk) is allowed until 2 h before anaesthesia, and solid food intake is recommended for up to 6 h prior to anaesthesia, so continuing medication usually does not create problems.

Beta-adrenergic blockers

Beta-adrenergic blockers are frequently used in the perioperative management of patients with cardiac disease due to their favourable effect on the supply and demand ratio of myocardial oxygen. Although still under debate, it is currently recommended that all patients who are already receiving beta-adrenergic blockers continue them perioperatively. Abrupt discontinuation can cause unstable angina, tachyarrhythmia, myocardial infarction and sudden death. If a patient who is scheduled for elective gastrointestinal surgery requires a new prescription, it should be started at least 1 month before the procedure to allow for dose adjustment.

Diuretics

Diuretics should not be used on the day of surgery because this may increase the risk of intraoperative hypovolaemia. However, it is strongly recommended that their intake be continued postoperatively, especially for patients who have heart failure.

Metformin

The relevance of the oral anti-diabetic drug metformin for inducing lactic acidosis has been controversially discussed in the literature. Regardless, it is recommended that its intake be stopped 48 h prior to the surgery.

Acetylsalicylic acid and thienopyridine derivatives

Anti-platelet therapy (usually 100 mg of acetylsalicylic acid daily) is standard for most patients with coronary artery disease. The 2009 European Society of Cardiology guidelines suggest that to reduce the risk of stent thrombosis and myocardial infarction, patients with a coronary bare metal stent (BMS) or a drug-eluting stent (DES) should receive anti-platelet therapy with both acetylsalicylic acid and a thienopyridine derivative (i.e., clopidogrel or ticlopidine) for 1 month (BMS) or 12 months (DES) after stent placement.

For patients who currently receive anti-platelet therapy and are scheduled for gastrointestinal surgery, the following wait times until surgery are recommended:

- After percutaneous transluminal coronary angioplasty without stent implantation: 2 weeks
- After BMS implantation: 6 weeks, but 3 months preferred
- After DES implantation: 1 year

For high-risk cardiac patients (i.e. patients with recent acute coronary syndrome, recurrent angina pectoris or recent surgical and conservative coronary intervention) who require major

surgery that cannot be postponed, thienopyridine derivatives should be stopped 7–10 days before the surgery, whereas acetylsalicylic acid should be continued during the entire perioperative period. This recommendation also applies to patients who require an epidural catheter.

L-Dihydroxyphenylalanine

L-Dihydroxyphenylalanine is the most frequently prescribed drug for Parkinson's disease. Because of its relatively short half-life, it should be continued during the entire perioperative period, as interrupting the medication can result in a life-threatening complication known as neuroleptic malignant-like syndrome, which is associated with fever, confusion and elevated concentrations of muscle enzymes.

Pacemaker or implantable cardioverter/defibrillator

An increasing number of patients who are referred to surgery have a PM or ICD. For these patients, the respective PM/ICD pass must be available to health care providers at any time during the patient's hospital stay. Potential electromagnetic interferences during surgery require certain safety arrangements for the patient. Unfortunately, evidence-based and uniformly accepted guidelines are lacking, and the large number of manufacturers and systems makes general safety recommendations extremely difficult.

Mechanical bowel preparation

The mechanistic rationale for MBP prior to gastrointestinal surgery is to clean the large bowel of faeces, thereby reducing the probability of infection after colorectal resection and protecting a colorectal anastomosis. However, several prospective randomised trials have demonstrated

that the outcome of patients who are scheduled for colorectal surgery is not significantly different for those who undergo MBP and those who do not. In addition, extensive MBP may induce abdominal discomfort, nausea and pain; it may impair postoperative oral nutrition, and it may result in electrolyte imbalance and dehydration. For these reasons, extensive MBP is not recommended any more.

The fast-track approach, however, is based primarily on open colorectal surgery, and it remains to be demonstrated whether avoidance of MBP can be directly translated into the laparoscopic setting, which is becoming more common for elective colorectal surgery.

Early oral nutrition

Early oral nutrition is recommended for non-emergency gastrointestinal surgery. An earlier practice had been temporary starvation; the rationale was to prevent postoperative nausea and to protect the surgical intestinal anastomosis from mechanical stress. However, several clinical trials failed to demonstrate a clear benefit for this practice, and early nutrition is now standard practice. Because postoperative nausea will prevent oral nutrition and hence limit early recovery and encourage postoperative ileus, nausea and vomiting should be treated with serotonin antagonists, low-dose dexamethasone, droperidol or dimenhydrinate.

Early detection of complications

The final important aspect of postoperative care is the early detection of complications. Elderly patients in particular are at increased risk for developing complications, mainly due to their reduced physiologic reserves, multiple (age-related) comorbidities, polypharmacy and a frequently altered response to commonly used drugs (altered pharmacodynamics and

pharmacokinetics). Because only a small group of patients accounts for the majority of postoperative morbidity and mortality after gastrointestinal surgery, it is crucial that these high-risk patients be identified. In addition, for these patients, extra efforts must be made to prevent potential complications and to identify actual complications as early as possible.

For elderly patients, a complication termed postoperative cognitive decline (POCD) appears to be an increasing problem. In contrast to postoperative delirium, which is defined as confusion and altered consciousness that lasts for days, POCD primarily effects memory and executive function and may last for weeks or months. It is unclear how this complication can be prevented, if at all.

CONCLUSION

Standard perioperative management in elective gastrointestinal surgery has advanced significantly in the last decade. As a truly multidisciplinary approach, it involves close interaction between the disciplines of surgery, anaesthesiology and intensive care medicine throughout the preoperative, intraoperative and postoperative phases. Major improvements have been based on evidence, and their implementation into routine clinical practice has enabled increasingly complex surgical procedures for an ageing patient population with significant comorbidities. For these reasons, major gastrointestinal surgery can now be safely performed with acceptable morbidity and mortality rates.

MATERIALS AND METHODS

1. Patients subjected to this study were taken from surgical units of Government Rajaji Hospital, Madurai over a period of 6 months from January 2016 to June 2016.

2. 50 patients underwent Gastrointestinal anastomosis surgeries (34 males and 16 females) for various abdominal conditions.

3. Factors such as age, sex, weight loss, anorexia, vomiting, diarrhea, fat wasting, muscle wasting, oedema and ascites were taken into account.

4. Patients were investigated with Haemoglobin, Serum Protein, Complete blood count, blood sugar, renal function test and ultrasonogram of abdomen and pelvis.

5. Patients were classified into 3 groups - A, B & C, based on their preoperative nutritional status using Subjective Global Assessment Score.

6. Patients were operated upon by experienced surgeons and Gastrointestinal anastomosis surgeries were done for their conditions.

7. The incidence of post-operative morbidity was assessed in each group of patients and its correlation with preoperative nutritional status as predicted by the SGA score was observed.

ETHICAL CLEARANCE:

ETHICAL CLEARANCE OBTAINED

CONSENT:

INDIVIDUAL WRITTEN AND INFORMED CONSENT OBTAINED FROM ALL 50 PATIENTS ENROLLED IN THE STUDY.

CONFLICT OF INTEREST : NIL

FINANCIAL SUPPORT : NIL

ELIGIBILITY CRITERIA

A. **Inclusion criteria**:

1. Patients - Age between 16 and 80 years in both sexes.
2. All patients undergoing elective Gastrointestinal surgeries involving bowel anastomosis.
3. Patients who consented for inclusion in the study according to designated proforma.

B. **Exclusion criteria**:

1. Patients undergoing emergency Gastrointestinal surgeries and major elective surgeries other than Gastrointestinal surgeries.
2. Patients who refused to give informed written consent.

OBSERVATION OF THE STUDY

The study included 50 patients of whom 39 were male patients and 11 were female patients. The patients were attending the surgical out-patients department of Government Rajaji Hospital, Madurai.

Among the 50 cases, the common age group of patients was between 46-60 years followed by patients between 31-45 years. Least incidence of requirement of surgery was found in young patients below 30 years of age.

The age distribution of the patients taken up for anastomotic surgeries is shown in table below:

AGE	No. of Cases	%
<30	6	12.00
31—45	13	26.00
46—60	21	42.00
>60	10	20.00
Total	50	100.00

The number of male patients requiring anastomosis surgeries in the study group was 39 as compared to 11 female patients, which constitutes 78% of males and 22% of females showing a male predilection of these diseases.

AGE	No. of Cases	%
Male	39	78.00
Female	11	22.00
Total	50	100.00

The commonest symptom occurring in the patients included in the group was weight loss occurring in more than 80% of patients:

Weight Loss	No. of Cases	%
Yes	41	82.00
No	9	18.00
Total	50	100.00

The least common finding in the patients was the presence of ascites which was seen in less than 15% of patients.

Ascites	**No. of Cases**	**%**
Yes	**7**	**14.00**
No	**43**	**86.00**
Total	**50**	**100.00**

Other common symptoms in the patients were:

Anorexia which was seen in **72%** of patients.

Fat loss seen in **54%** of patients.

Vomiting which occurred in **48%** of patients.

The various diagnoses for which patients were admitted are as follows which shows carcinoma of stomach to be the commonest diagnosis in these patients:

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The following table shows the various procedures performed in the study group which shows that Gastrojejunostomy and Right Hemicolectomy to be the commonest procedures that were performed for the patients:

Procedure	No. of Cases	%
APR	3	6.00
Coloplasty	1	2.00
Distal Gastrectomy	6	12.00
Gastrojejunostomy	7	14.00
Ileotransverse anas	2	4.00
Limited resection	1	2.00
Low anterior resec	1	2.00
Lt. Hemicolectomy	2	4.00
Oesophagojejunos	3	6.00
Palliative bypass	3	6.00
Resection anastom	6	12.00

Rt. Hemicolectomy	7	14.00
Stoma takedown	4	8.00
Total Gastrectomy	2	4.00
Whipple's procedu	2	4.00
Total	50	100.00

The study did not reveal any significant difference in the occurrence of morbidity in males and females. The following table shows the absence of any significant sex predilection in the occurrence of morbidity in the patients:

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Sex vs Morbitity	**Yes**	**No**	**Total**
MALE	**18**	**21**	**39**
FEMALE	**5**	**6**	**11**
Total	**23**	**27**	**50**

BMI vs Morbidity	Yes	No	Total
<18.5	16	0	16
>18.5	7	27	34
Total	23	27	50

The study shows a significant correlation between **low BMI** and postoperative morbidity with all patients developing morbidity

The observation made during the study regarding the correlation of SGA score and postoperative morbidity showed that patients belonging to Group A had a better post-operative outcome when compared to patients in Group B who had a significantly better outcome compared to patients in Group C:

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DISCUSSION OF THE STUDY

In the study conducted, 50 patients were included out of which 39 patients were male and 11 patients were female patients.

Patients most commonly belonged to 46-60 years age group which included 42% of patients followed by 26% of patients belonging to 31-45 years age group. The least occurrence was seen in less than 30 years age group.

The commonest symptom that occurred in the patients was weight loss which was seen in 41 out of 50 patients constituting 82% of the study group.

Other clinical features included anorexia seen in 72% of patients, fat loss in 54%, vomiting seen in 48%, diarrhea seen in 40%, muscle wasting in 28%, oedema in 18%, least common being ascites seen in 14% of patients.

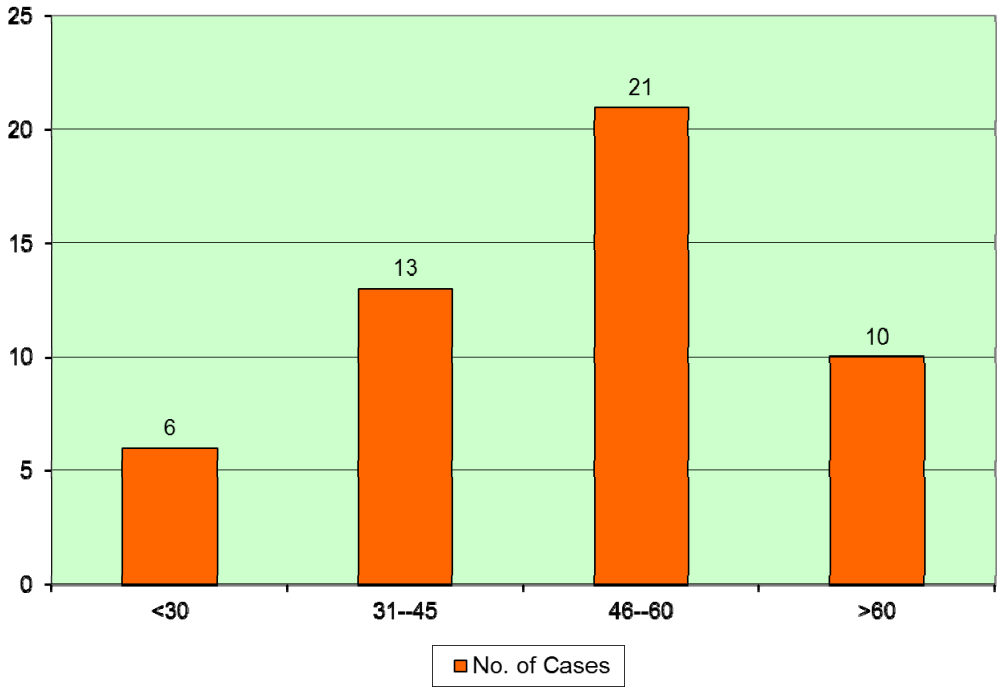
The incidence of vomiting was seen to be higher in patients having upper gastrointestinal pathology while diarrhea was more common in patients with colonic and distal small intestinal disorders.

The commonest condition seen in the patients was Carcinoma Stomach which was the diagnosis in 8 patients out of 50, constituting 16% of the study group.

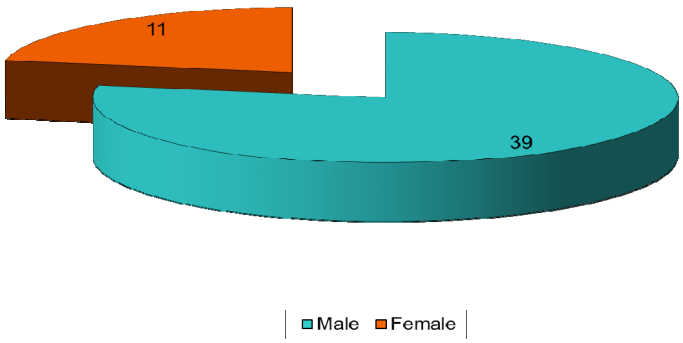
The most frequently performed procedures were Gastrojejunostomy and Right Hemicolectomy which were performed in 7 patients each, constituting 14% each of the total study group.

There was no significant difference in the incidence of postoperative morbidity in male and female patients.

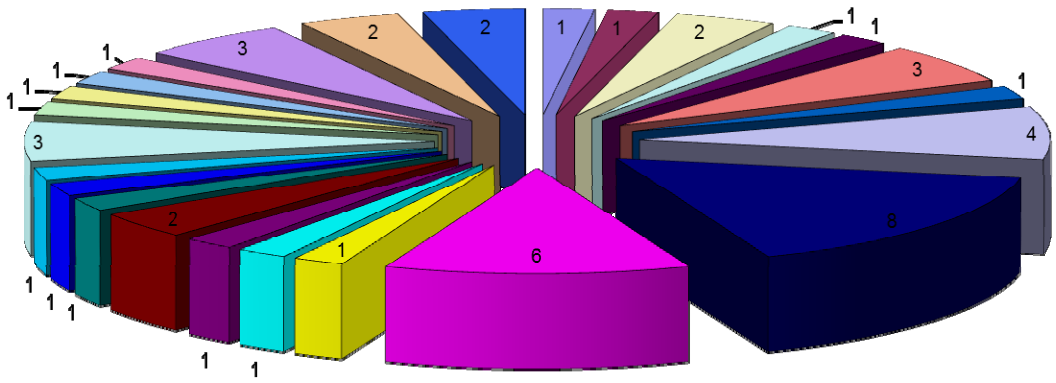
AGE DISTRIBUTION



SEX DISTRIBUTION

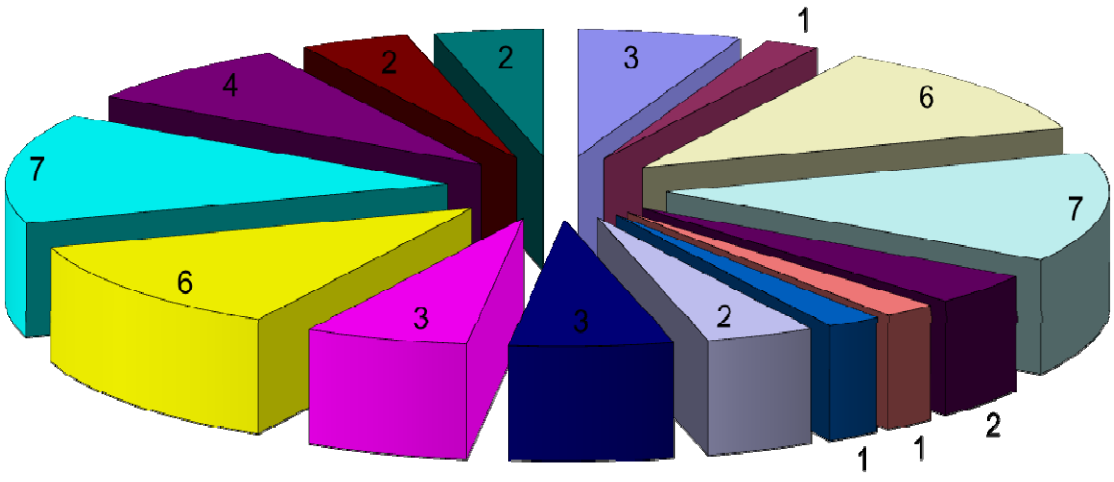


DIAGNOSIS



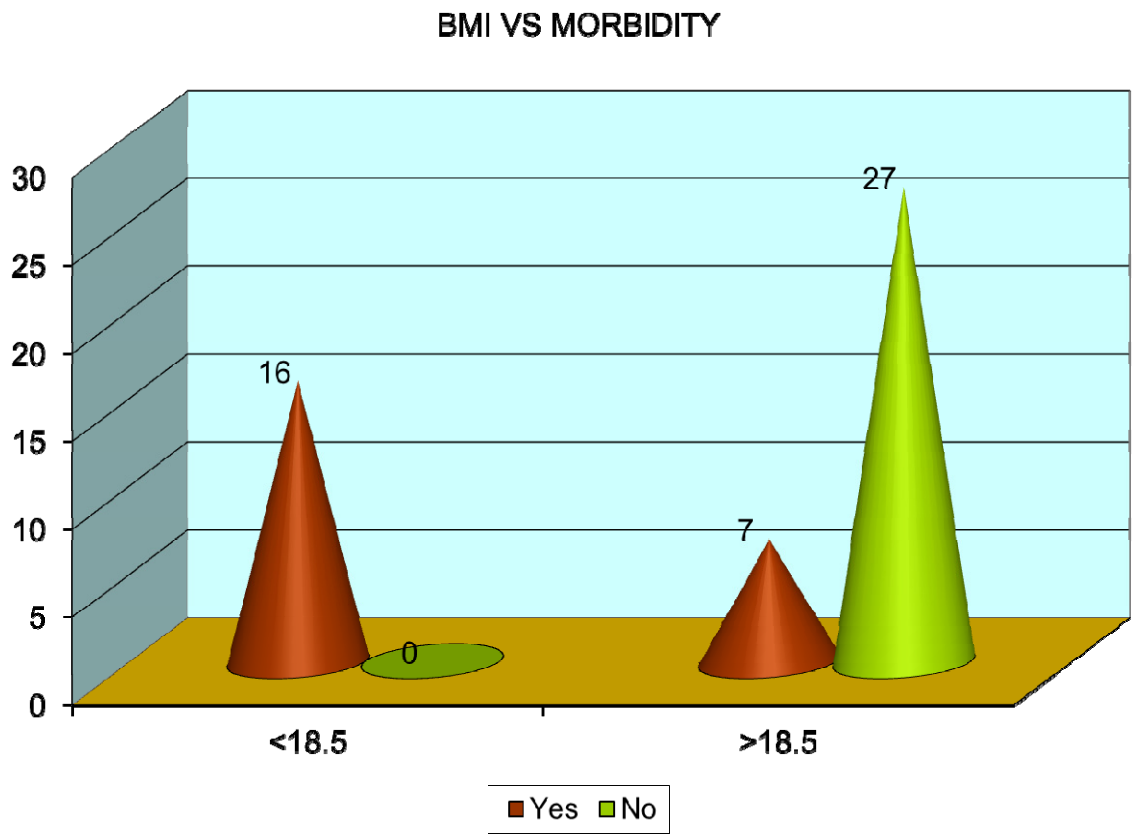
ascending colon growth	ca - head of pancreas	caecal carcinoma	carcinoid appendix
carcinoma caecum	carcinoma oesophagus	carcinoma rectosigmoid jn.	carcinoma rectum
carcinoma stomach	cicatrized duodenal ulcer	descending colon growth	enterogenous cyst
GIST	hepatic flexure growth	ileal band	ileal interloop abscess
ileal stricture	ileocaecal tb	jejunal stricture	meckel's diverticulum
oesophageal stricture	pancreatic carcinoma	periampullary carcinoma	post-hartmann's procedure
post-ileostomy status			

PROCEDURE



APR
Coloplasty
Distal Gastrectomy
Gastrojejunostomy
Ileotransverse anas
Limited resection
Low anterior resec
Lt. Hemicolectomy
Oesophagojejunos
Palliative bypass
Resection anastom
Rt. Hemicolectomy
Stoma takedown
Total Gastrectomy
Whipple's procedu

The importance of preoperative BMI in the study group has been observed to be significant with all patients belonging to low BMI of less than 18.5 developing complications postoperatively compared to less than 20% of patients with normal BMI developing morbidity.

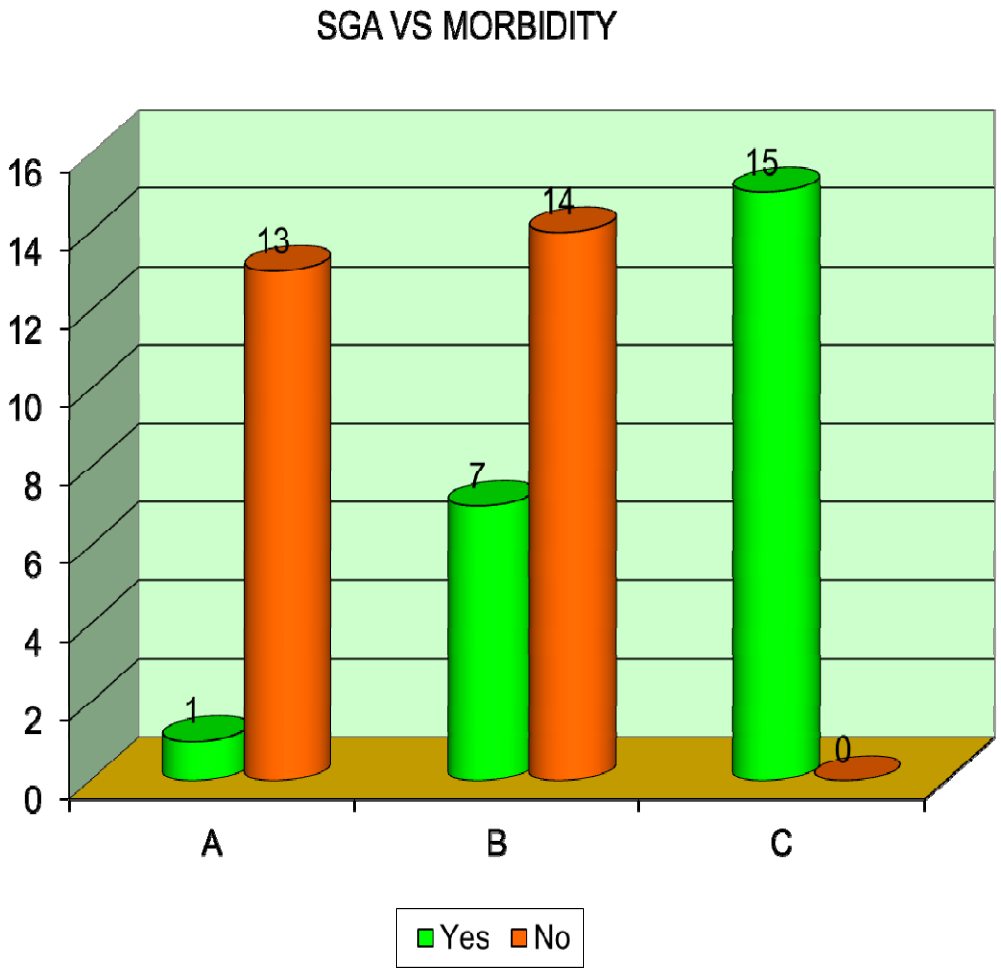


Coming to the most important aspect of the study which is the Subjective Global Assessment score: out of 14 patients who belonged to the well nourished SGA Group A, only 1 patient was found to have developed postoperative morbidity, namely requirement of postoperative blood transfusion.

One third of patients, namely 7 out of 21 patients belonging to the moderately nourished Group B, developed postoperative complications. Out of the 7 patients, 3 of them required blood transfusions, 2 patients required fresh frozen plasma and albumin transfusion, 1 patient required ventilator support and 1 patient developed anastomotic leak which was managed conservatively.

In the study group, 15 patients belonged to SGA Group C or the poorly nourished group. Of these, all 15 patients developed postoperative morbidity and required prolonged intensive care and hospital stay.

8 out of 15 patients required both blood and fresh frozen plasma transfusions for a minimum of 3 days and a maximum of 5 days. 3 patients developed postoperative anastomotic leak of which 2 patients had to be reoperated and stoma was created. 4 patients required ventilatory support for a minimum of 2 days and maximum of 6 days. 10 out of these 15 patients developed postoperative wound infect


SGA VS MORBIDITY
16
14
12
10
8
6
4
2
0
1
13
7
14
15
0
A
B
C
Yes
No

CONCLUSION

The study was successfully completed and the Subjective Global Assessment score proved to be 100% successful in predicting postoperative morbidity in poorly nourished patients.

The study shows the correlation between preoperative nutritional status of patients undergoing gastrointestinal anastomotic surgeries and the corresponding postoperative morbidity in these patients.

Thus, the Subjective Global Assessment score is a valuable tool in predicting the occurrence of postoperative complications in patients whose preoperative nutritional status is below optimum level. Implementing this scoring system routinely in our wards prior to taking up patients for major surgeries and optimizing the nutritional status (improving status from Group C to Group A) with preoperative nutritional support will reduce the incidence of adverse outcomes in patients and will consequently reduce the health related monetary as well as resource expenditure of the State.

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Acknowledgements: This study was supported by an unre- gram for public health professionals. Atlanta, Georgia, USA: stricted research grant from JRD Tata Trust, Mumbai. The Centers for Disease Control and Prevention. 2002. findings were presented at the Annual Conference of Indian

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PROFORMA

Name: Age: Sex:

IP No: Contact no.:

DOA:

Chief Complaints

History

Examination Findings

Pulse :

BP :

Investigations

Hb

Serum Protein

USG Abdomen & Pelvis :

Final diagnosis

Procedure planned

Subjective Global Assessment

Name:
Date:

Medical History			A	B	C
WEIGHT	Usual weight…….	Current weight…….			
Wt change past 6 months	Amount weight loss…….	% weight loss…….			
0-<5% loss			*		
5-10% loss				*	
>10% loss					*
Weight change past 2 weeks		Amount……..			
No change; normal weight			*		
Increase to within 5%			*		
Increase (1 level above)			*	*	
No change, but below usual wt				*	
Increase to within 5-10%				*	
Decrease					*
DIETARY INTAKE					
No change; adequate			*		
No change; inadequate				*	
Change	**Duration of change**……...				
Suboptimal diet				*	
Full liquid				*	
Hypocaloric liquid					*
Starvation					*
Intake borderline; increasing			*		
Intake borderline; decreasing				*	
Intake poor; no change				*	*
Intake poor; increasing				*	
Intake poor; decreasing					*
GASTROINTESTINAL SYMPTOMS					
	Frequency (never, daily, no. of times/week)	Duration (<2wk, >2wk)			
Nausea	……	……..			
Vomiting	……	…….			
Diarrhoea	……	……...			
Anorexia	……	……...			
None; intermittent			*		
Some (daily >2 week)				*	
All (daily >2 week)					*
FUNCTIONAL CAPACITY					
No dysfunction	Duration of change ……..		*		
Difficulty with ambulation/normal activities				*	
Bed/chair-ridden					*
Change past 2 week					
Improved			*		
No change				*	
Regressed					*

Posted: May 2009
Due for Review: November 2014

Physical examination	A	B	C
SUBCUTANEOUS FAT			
Under the eyes	Slightly bulging area		Hollowed look, depression, dark circles
Triceps	Large space between fingers		Very little space between fingers, or fingers touch
Biceps	Large space between fingers		Very little space between fingers, or fingers touch
MUSCLE WASTING			
Temple	Well-defined muscle/flat	Slight depression	Hollowing, depression
Clavicle	Not visible in Males; may be visible but not prominent in females	Some protrusion; may not be all the way along	Protruding/prominent bone
Shoulder	Rounded	No square look; acromion process may protrude slightly	Square look; bones prominent
Scapula/ribs	Bones not prominent; no significant depressions	Mild depressions or bone may show slightly; not all areas	Bones prominent; significant depressions
Quadriceps	Well rounded; no depressions	Mild depression	Depression; thin
Calf	Well developed		Thin; no muscle definition
Knee	Bones not prominent		Bones prominent
Interosseous muscle between thumb and forefinger	Muscle protrudes; could be flat in females		Flat or depressed area
OEDEMA (related to malnutrition)	No sign	Mild to moderate	Severe
ASCITES (related to malnutrition)	No sign	Mild to moderate	Severe
OVERALL SGA RATING	**A**	**B**	**C**

Adapted from: Detsky et al., 1994[8]; Baxter Healthcare Corporation, 1993; McCann, 1996 (Ferguson, Bauer, Banks, Capra, 1996)©

MADURAI MEDICAL COLLEGE
MADURAI, TAMILNADU, INDIA -625 020
(Affiliated to The Tamilnadu Dr.MGR Medical University, Chennai, Tamil Nadu)

ETHICS COMMITTEE CERTIFICATE

Name of the Candidate	:	Dr.Mohamed Aabrez shams
Course	:	PG in MS., General Surgery
Period of Study	:	2014-2017
College	:	MADURAI MEDICAL COLLEGE
Research Topic	:	Evaluation of preoperative nutritional status using subjective global assessment score in predicting postoperative outcomes in patients undergoing gastrointestinal anastomosis surgeries
Ethical Committee as on	:	27.07.2016

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Member Secretary Chairman Dean / Convenor

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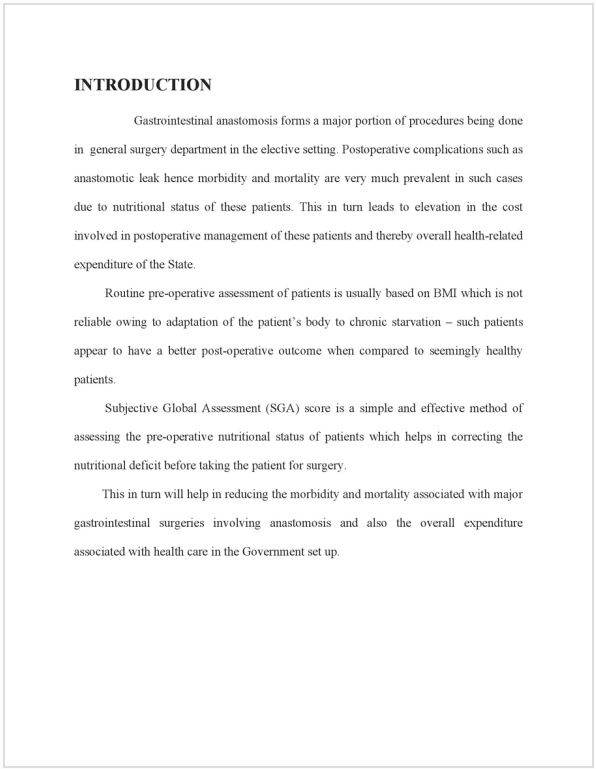

INTRODUCTION

Gastrointestinal anastomosis forms a major portion of procedures being done in general surgery department in the elective setting. Postoperative complications such as anastomotic leak hence morbidity and mortality are very much prevalent in such cases due to nutritional status of these patients. This in turn leads to elevation in the cost involved in postoperative management of these patients and thereby overall health-related expenditure of the State.

Routine pre-operative assessment of patients is usually based on BMI which is not reliable owing to adaptation of the patient's body to chronic starvation – such patients appear to have a better post-operative outcome when compared to seemingly healthy patients.

Subjective Global Assessment (SGA) score is a simple and effective method of assessing the pre-operative nutritional status of patients which helps in correcting the nutritional deficit before taking the patient for surgery.

This in turn will help in reducing the morbidity and mortality associated with major gastrointestinal surgeries involving anastomosis and also the overall expenditure associated with health care in the Government set up.

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BY 221411125 MS GENSUR MOHAMED AABREZ SHAMS

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INTRODUCTION

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2	Andavar	1077960	55	1	Y	Y	Y	N	N
3	Chellam	1078808	61	1	Y	Y	N	N	N
4	Selvarani	1078838	44	2	N	Y	N	Y	N
5	Ponni	1080117	26	2	Y	N	Y	N	N
6	Karthigaisamy	71776	45	1	Y	N	Y	N	N
7	Irulayee	1078806	65	2	Y	Y	N	Y	N
8	Murugan	1080111	40	1	Y	Y	Y	N	N
9	Kaliappan	1074670	70	1	Y	Y	Y	N	N
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15	Boominathan	1071892	55	1	N	Y	N	Y	N
16	Panchasaram	1076226	49	1	Y	N	N	N	N
17	Kannan	14965	42	1	Y	Y	N	Y	N
18	Jayaraj	1084129	18	1	N	Y	Y	Y	N
19	Radhakrishnan	1085477	50	1	Y	Y	Y	N	N
20	Ammaponnu	1085339	56	2	Y	N	Y	N	N
21	Kaliyamurthy	1082538	33	1	Y	N	N	Y	N
22	Muruganandam	1086921	42	2	Y	N	N	Y	N
23	Silambayee	1087024	57	2	Y	Y	Y	N	Y
24	Karuppaiya	1087836	47	1	Y	Y	N	Y	N
25	Parthasarathy	47438	54	1	Y	Y	Y	N	Y
26	Prakash	1086965	42	1	N	Y	Y	N	Y
27	Andi	1088631	49	1	N	N	N	Y	Y
28	Ayyappan	47414	60	1	Y	Y	N	Y	Y
29	Sekaramoorthy	1089848	52	1	Y	Y	Y	N	Y
30	Saravanan	1090470	20	1	Y	Y	N	N	Y
31	Ramar	1083349	62	1	Y	Y	N	N	Y
32	Valli	1090296	46	2	N	Y	N	Y	N
33	Perumal	1091879	61	1	Y	Y	N	N	Y
34	Rajendran	1091173	29	1	N	Y	Y	N	Y
35	Nagarajan	1092642	53	1	Y	Y	N	Y	Y
36	Kassammal	1094721	35	2	Y	N	Y	N	Y
37	Sivakumar	47433	41	1	Y	N	N	N	Y
38	Velusamy	1094100	63	1	Y	N	N	Y	Y
39	Nagarajan	1094177	38	1	Y	Y	N	Y	N
40	Subbaiya	1072585	62	1	Y	Y	Y	N	Y
41	Karupaiya	1094984	50	1	N	Y	Y	N	Y
42	Balamurugan	1091080	54	1	Y	N	Y	Y	N
43	Prithviraj	1092543	55	1	Y	N	N	N	Y
44	Saravanan	1096656	20	1	Y	N	Y	N	Y
45	Thangapandi	1095100	49	1	Y	Y	N	Y	Y
46	Bharathimuthu	1096771	48	2	Y	Y	Y	N	Y
47	Ranjith	1098188	35	1	Y	Y	Y	N	Y
48	Nagapandi	1099564	51	1	Y	Y	Y	N	Y
49	Govindan	1100751	29	1	N	N	N	Y	Y
50	Narayanan	1120536	61	1	Y	Y	Y	N	Y

muswast	oedema	ascites	diagnos	proce	bmi	sga	morbidit
Y	Y	2	carcinoma caecum	Rt. Hemicolectomy	17.9	3	Y
N	Y	2	carcinoma stomach	Distal Gastrectomy	19.3	2	N
Y	Y	1	periampullary carcinoma	Palliative bypass	16.4	3	Y
N	N	2	ileocaecal tb	Limited resection	21.2	1	N
N	N	2	cicatrized duodenal ulcer	Gastrojejunostomy	23.4	1	N
N	N	2	GIST	Distal Gastrectomy	22.7	1	N
Y	Y	2	carcinoma rectum	APR	17.1	3	Y
N	N	2	carcinoma oesophagus	Oesophagojejunos	18.8	2	N
N	N	2	periampullary carcinoma	Whipple's procedu	18.1	2	Y
Y	N	1	hepatic flexure growth	Rt. Hemicolectomy	17.5	3	Y
N	N	2	ileal interloop abscess	Resection anastom	22.6	1	N
Y	N	2	oesophageal stricture	Coloplasty	17.3	3	Y
N	N	2	carcinoma stomach	Total Gastrectomy	19.9	2	N
Y	Y	2	carcinoma rectum	APR	16.8	3	Y
N	N	2	descending colon growth	Lt. Hemicolectomy	20.6	1	N
N	N	2	post-ileostomy status	Stoma takedown	22.5	1	N
N	Y	2	caecal carcinoma	Rt. Hemicolectomy	19.7	2	Y
N	N	2	meckel's diverticulum	Resection anastom	23.2	1	N
Y	N	2	carcinoma stomach	Total Gastrectomy	17.4	3	Y
N	N	2	cicatrized duodenal ulcer	Gastrojejunostomy	21.6	2	N
N	N	2	ileal stricture	Resection anastom	20.5	2	N
N	N	2	post-hartmann's procedure	Stoma takedown	20.7	1	N
N	N	1	pancreatic carcinoma	Palliative bypass	17.9	3	Y
N	N	2	ileocaecal tb	Rt. Hemicolectomy	20.1	2	N
N	N	2	carcinoma stomach	Distal Gastrectomy	21.2	2	Y
N	N	2	cicatrized duodenal ulcer	Gastrojejunostomy	19.9	1	N
N	Y	1	ascending colon growth	Ileotransverse anas	18.1	3	Y
Y	N	2	carcinoma rectum	Low anterior resec	17.2	3	Y
Y	N	1	carcinoma oesophagus	Oesophagojejunos	17.6	3	Y
N	N	2	periampullary carcinoma	Whipple's procedu	19.3	2	Y
N	N	2	hepatic flexure growth	Ileotransverse anas	20.5	2	N
N	N	2	carcinoma rectosigmoid jn.	Lt. Hemicolectomy	21.7	1	Y
Y	Y	1	ca - head of pancreas	Palliative bypass	18.2	3	Y
N	N	2	carcinoma stomach	Distal Gastrectomy	19.8	2	Y
Y	Y	2	carcinoma rectum	APR	17.9	3	Y
N	N	2	cicatrized duodenal ulcer	Gastrojejunostomy	20.4	2	N
N	N	2	post-ileostomy status	Stoma takedown	22.6	1	N
Y	N	2	caecal carcinoma	Rt. Hemicolectomy	19.2	2	N
N	N	2	carcinoid appendix	Rt. Hemicolectomy	21.5	2	Y
Y	N	1	carcinoma stomach	Gastrojejunostomy	18.1	3	Y
N	N	2	cicatrized duodenal ulcer	Gastrojejunostomy	21.2	1	N
N	N	2	jejunal stricture	Resection anastom	20.7	2	N
N	N	2	post-hartmann's procedure	Stoma takedown	22.6	1	N
N	N	2	ileal band	Resection anastom	21.3	2	N
N	N	2	ileocaecal tb	Rt. Hemicolectomy	18.6	2	Y
N	N	2	carcinoma stomach	Distal Gastrectomy	19.4	2	N
N	N	2	cicatrized duodenal ulcer	Gastrojejunostomy	20.2	2	N
N	N	2	carcinoma stomach	Distal Gastrectomy	19.1	2	N
N	N	2	enterogenous cyst	Resection anastom	21.7	1	N
Y	N	2	carcinoma oesophagus	Oesophagojejunos	16.9	3	Y